PETROLEUM NOVEMBER, 1951

REFINER

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THE Chicago Bridge & Iron Company has developed a complete line of storage tanks to solve one of the petroleum industry's biggest problems—EVAPORATION. They include Hortonspheres for the storage of the more volatile hydrocarbons under pressure—Hortonspheroids and Hemispheroids for the storage of less volatile hydrocarbons—Horton Floating Roofs to stop evaporation, cut down on corrosion, and reduce fire hazard on working storage tanks—and Hortondome Roofs to prevent evaporation losses during standing storage. If you are interested in obtaining the advantages of more efficient storage, write our nearest office.

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Are you making the most of BECKMAN pH METERS in your refining operations?

THE BECKMAN MODEL H-2 pH METER is one of a complete range of Beckman pH Meters available for every type of application*. The H-2 is particularly recommended for applications where high accuracy and simple operation—combined with the convenience and low cost of 115-v. AC operation—are desired.

It provides instant and direct pH readings, and a simple, built-in dial permits quick, convenient temperature compensation over the entire range of 0° to 100°C (32° to 212° F.). High reading accuracy is assured by wide-spread dual range scale that reads from 0 to 8 pH or from 6 to 14 pH at the turn of a switch. Same switch also provides instant millivolt readings from 0 to ±800 mv and from ±600 to ±1400 mv for titrations and oxidation-reduction measurements.

Built-in electrode support and compact case design save valuable space and permit easy portability to various plant locations.

Particularly important is the wide range of factory-sealed, maintenance-free Beckman Glass Electrodes available for use with this instrument . . . electrodes that are virtually unbreakable . . . that cover extreme temperature ranges from below freezing to above boiling . . . that have an unprecedented pH range with negligible errors . . . that are abrasion-resistant and chemically durable to a degree never before thought possible in glass electrodes.

*In addition to the H-2 Meter, other Beckman pH equipment includes completely automatic pH indication and control instruments for large-scale process applications . . . battery-operated models for complete portability in plant and field use . . . and a laboratory type instrument that features maximum versatility and accuracy for research and laboratory applications

Five ways to improve refinery operations with Beckman pH Control

Leading refineries are using Beckman pH Control for many profitable applications that save time and money, reduce maintenance and increase plant efficiency. Whether yours is a small or large refinery, we suggest that you investigate the savings to be made by such typical applications as these . . .

1. **NEUTRALIZING CRUDE STOCK ACIDITIES** *to prevent damage and corrosion to costly equipment.*
2. **MAINTAINING CONSTANT COOLING WATER CHECK** *for immediate detection of hidden leaks in lines and equipment.*
3. **NEUTRALIZING ACIDS IN STILLS** *to assure a uniform acid-free product.*
4. **TREATING PROCESS AND BOILER FEED WATER** *to assure soft, neutral water, greater freedom from liming and boiler maintenance, and substantial savings in chemicals.*
5. **RELIABLE CONTROL OF WASTE DISPOSAL** *with better neutralization of acid and caustic effluents . . . at lower chemical costs.*

These are only typical of the many money-saving ways modern refineries are using Beckman pH Control. See your nearest authorized Beckman dealer for more details on these and other refinery applications—or write direct.

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REFINER

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R. L. DUDLEY, President — A. L. BURNS, General Manager
VOLUME 30, NO. 11 — NOVEMBER, 1951

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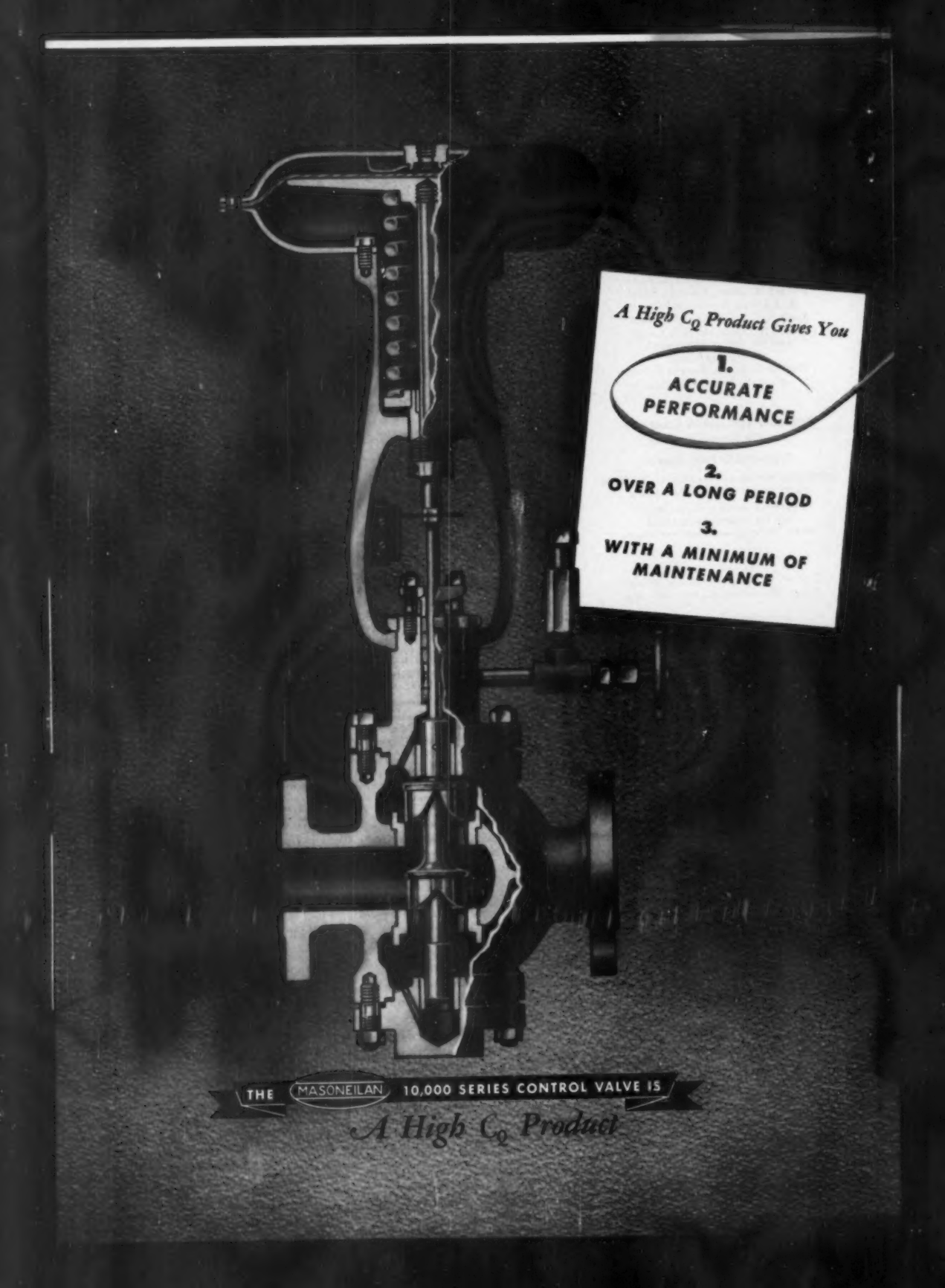
A High C_Q Product Gives You
1.
ACCURATE PERFORMANCE
2.
OVER A LONG PERIOD
3.
WITH A MINIMUM OF MAINTENANCE
THE MASONEILAN 10,000 SERIES CONTROL VALVE IS
A High C_Q Product

In Control Valve Performance the No. 1 Quality Factor is

Accuracy

A number of other quality factors enter into the design and manufacture of a control valve which provides "accurate performance, over a long period, with a minimum of maintenance". Such interrelated factors as rugged mechanical construction; selection of materials, types, sizes, and associated equipment; convenience in servicing, etc. are important. But without accurate performance these are meaningless.

Here is how Masoneilan Control Valves are designed and built to assure this accurate performance:

Correct Flow Characteristics
Plug contours designed and flow tested to provide accurate flow characteristics over widest practical range. A variety of precision machined plugs permits selection of most suitable construction as well as the desired flow characteristics for the service conditions.

Wide Flow Range
Low minimum flow (because of smallest practical clearance between plug and seat ring obtainable by precision machining), large diameter seat rings and long stroke combine to insure wide usable flow range.

Large Body Flow Areas
provide required C_v with minimum pressure drop due to body restrictions.

Responsive, Positive Diaphragm Motor
with large diaphragms, pre-formed to provide sensitivity and power, to maintain effective area throughout valve stroke and to minimize hysteresis. Calibrated springs for 3-15 or 6-30 psi range. Stop in upper diaphragm case establishes correct initial diaphragm position, avoiding faulty adjustment.

Accurate Alignment
from diaphragm to blindhead, insured by pre-formed diaphragm; by precision control of clearance in stuffing box parts, guide bushings and plug guide section; by piloting of seat rings in body bridge wall; by piloting one-piece bonnet and blindhead in body; by rigid fastening of diaphragm motor to body by heavy forged steel drive nut.

Minimum Friction
insured by accurate alignment; by finish of honed and highly polished valve stems; by finish of extra deep stuffing box parts; by self-aligning frictionless guide provided by diaphragm; by oilite bronze lower guide.

In selecting control valves consider first the "Accuracy of Performance" quality factor — but evaluate the other quality factors too — the factors that insure accuracy "for a long period, with a minimum of maintenance". For the sum of *all* quality factors is the C_Q (Quality Coefficient) and in comparing cost remember that the *real* cost includes invoice price plus cost of maintenance and down-time. Thus for comparison, among comparably priced valves the best buy is the one with the highest Quality Coefficient —

$$\text{for Real Cost} = \frac{\text{Price}}{C_Q}$$

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Which tube steel is the one and only for you? Ask the experts!

This month's report is on: **SICROMO 5S**

High degree of surface stability under oxidizing conditions up to 1500° F., makes it excellent for air preheater tubes, recuperator and superheater tubes, incinerator equipment. In cracking tubes, offers good resistance to corrosion by hot petroleum and excellent stability up to 1500° F.

23 TIMKEN STEELS FOR HIGH TEMPERATURE SERVICE

Carbon	Sicromo 2	Sicromo 5S	16-13-3
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	25-20
DM-2	2¼% Cr.-1% Mo.	Sicromo 7	25-12
Silmo	Sicromo 3	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

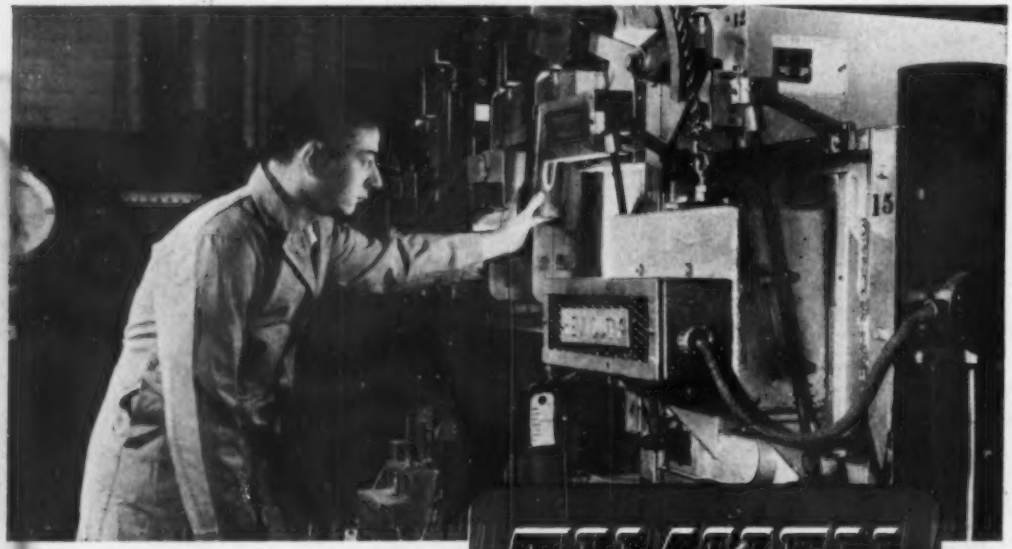
*Not available as seamless tubing at the present time.

One and *only* one high temperature tube steel can give the best life/cost ratio under a particular set of heat, pressure, corrosion and oxidation conditions.

To make sure you select the right steel for *your* operating conditions, get the help of the recognized authorities on high temperature steels—the Timken Company's metallurgists. Their knowledge has been gained through the development and testing of 23 analyses to solve specific high temperature problems. They'll help you choose the one steel out of the 23 that will give you the most life per dollar. And you can be sure that analysis will be uniform from shipment to shipment, because of the Timken Company's complete quality control.

Let our "RSQ"—Research, Supply, Quality—solve your tube problems. Ask the experts! The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

Photo shows furnaces in the Timken Company's experimental heat treating laboratory. Pioneering research on high temperature steels' properties is one big reason for the Timken Company's leadership.



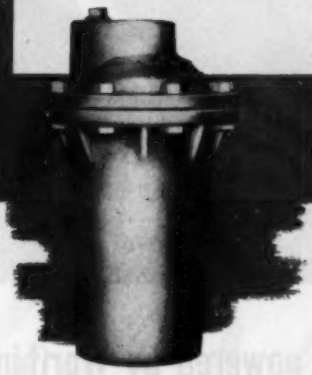
YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing

NO STEAM LOSS

FROM ZERO TO FULL LOAD

ARMSTRONG TRAPS DON'T PASS STEAM



UNLIKE some devices, Armstrong traps will not pass steam, regardless of load conditions. The diagrams at the right show this conclusively. Under no-load conditions here is what happens: steam in the bucket eventually condenses due to radiation loss. When enough condensate is formed in this manner to cause the bucket to lose buoyancy and sink, the trap empties itself and the cycle repeats. The radiation loss is small—as it would be in any device of similar size. There is no steam loss!

When there is a condensation load, the operation is the same except that the trap remains open until all condensate flowing into it is discharged.

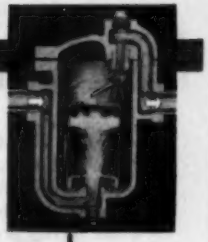
Freedom from steam loss saves fuel, keeps down back pressure in return lines. Call your nearby Armstrong Representative for the traps you need now.

ARMSTRONG MACHINE WORKS

852 Maple Street • Three Rivers, Michigan

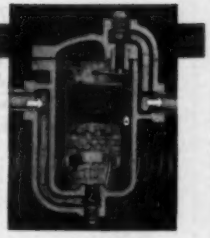
OPEN

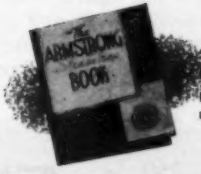
When accumulated water causes bucket to lose buoyancy, trap opens wide.



CLOSED

After condensate is discharged, steam entering bucket causes it to float, closing the valve tight. Valve remains closed until steam condenses.

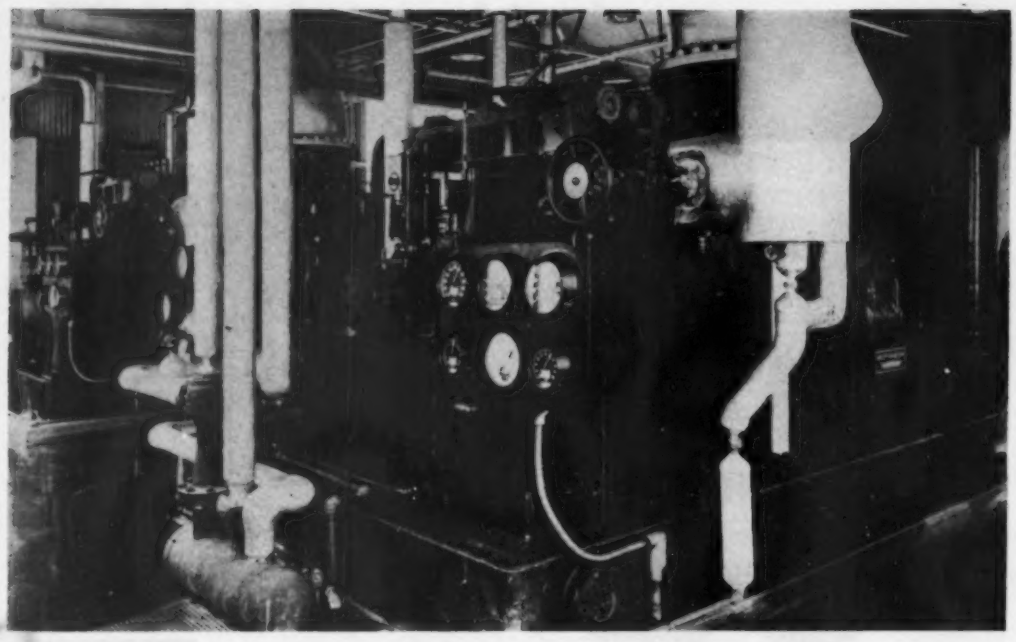




SEND FOR THE 36-PAGE STEAM TRAP BOOK. It tells you how to do the best possible trapping job with facts, figures and diagrams.

SEE OUR CATALOG IN SWEET'S or CEC

ARMSTRONG STEAM TRAPS



Three Jobs for Steam—all powered by Worthington

They get a lot of work out of steam at Burnell-North Pettus Cycling plant near Pettus, Texas, operated by Stanolind Oil and Gas Company.

The Worthington turbine generator shown above is one of two providing electric power for general plant service. The steam turbines are 1,500 kw units, operating at 600 lb. gauge, 725 Ftt, and exhausting to 27 in. vacuum. The generators operate at three phase, 60 cycles, 70% power factor and are equipped with top-mounted air coolers.

There are also *nine* Worthington mechanical-drive turbines at this plant. Seven of these drive centrifugal pumps, and two drive induced-draft fans.

So — three jobs in all: electricity, pumps, fans.

This reliance on Worthington steam turbines is duplicated throughout the petroleum industry. Whether you want turbine-generator sets up to 10,000 kw or mechanical-drive turbines, Worthington has the correct type and size, with the petroleum industry's stamp of approval. A broad line of power plant equipment, giving you *unit responsibility*, and our unmatched experience in power plant applications are further reasons for doing business with Worthington.

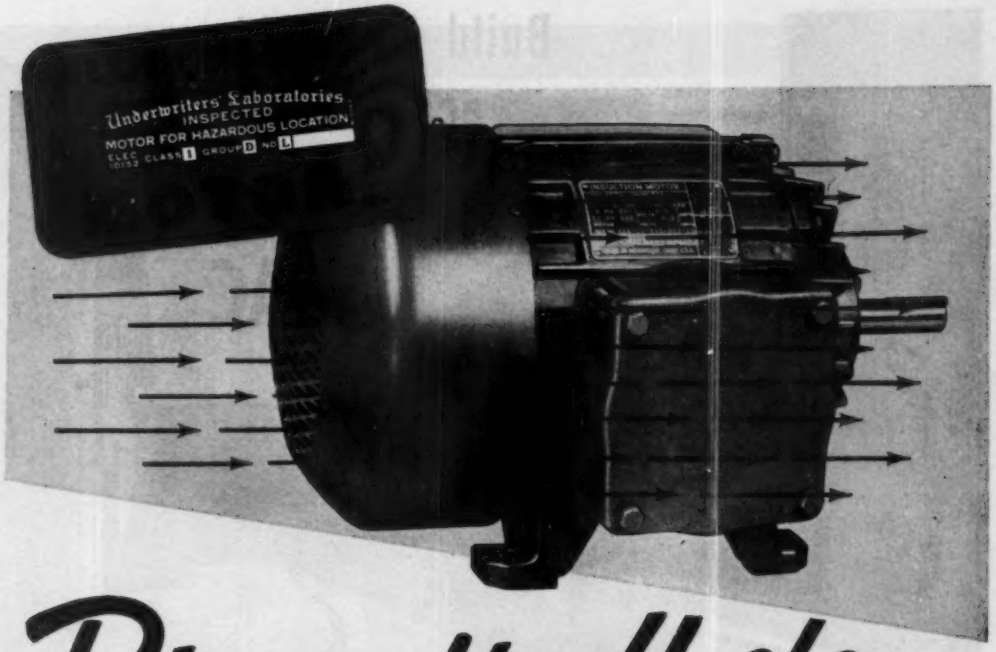
Get the *savings* that steam offers—get *more work* out of steam. *There's more worth in Worthington.* For bulletins, write Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N.Y.

WORTHINGTON

STEAM TURBINES

T.1.2

A GREAT TEAM IN STEAM



Blows itself clean as a Whistle!

DIRT IS CARRIED AWAY by cooling air blown over the ribbed cast iron frame and bearing housings of this new Allis-Chalmers explosion proof motor. That means less motor cleaning . . . inspection . . . overhaul!

Concealed air passages and pockets have been eliminated. Dirt can't build up to cause overheating. And as for oily dirt that sticks — just wipe or blow it off.

This means savings. This new Allis-Chalmers Type APZZ explosion proof motor makes maintenance costs lower than ever before.

Rigid Construction

The frame is cast iron which has high resistance against corrosion and distortion. Bearings are pre-lubricated at the factory and should need no attention for years. Tapped holes with pipe plugs to permit regreasing and to provide grease relief are standard equipment

Get All The Facts

The new Allis-Chalmers Type APZZ explosion proof motor is built in all NEMA standard frame sizes from 224* to 505. Also built in totally-enclosed, fan-cooled type. Your nearby Allis-Chalmers Distributor or Sales Office has complete information on this new motor. Call today, or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B7286.

A-3477

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CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

Texrope and Vari-Pitch are Allis-Chalmers trademarks.

ALLIS-CHALMERS

*Similar design non-ventilated motors Type APKK also available in frames 203 to 224 inclusive.

Build it quickly ... economically with "Century"® APAC

Track-side building with both exterior and interior walls of "Century" APAC

Whatever your construction plans—interior, exterior, new structures, or modernization—you'll build better, at less cost, with "Century" APAC . . . Keasbey & Mattison's versatile asbestos-cement structural sheet.

Consider the advantages of building with APAC: It's a low-cost material of stone-like durability. Application is quick and inexpensive: Sheets are large size (standard 4′ x 8′); are easily cut and fitted on the job; can be fastened with ordinary nails or screws. Labor costs are low.

And APAC needs but a minimum of maintenance! The all-mineral asbestos and cement composition resists weather and moisture—*can't burn*—is unaffected by rodents or termites and will not rust or rot. The attractive natural gray surface never needs protective painting!

These are just a few of the many reasons why so many plants are using "Century" APAC for siding, office panelling, fire-resistant sheathing in shops and stock-rooms, storage bins, linings for elevator casings, shower stalls —to name but a few uses. We'll be glad to send you complete information on "Century" APAC, and the name of your nearest distributor. Write us.

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K&M best in asbestos

Nature made Asbestos...
Keasbey & Mattison has made it serve mankind since 1873

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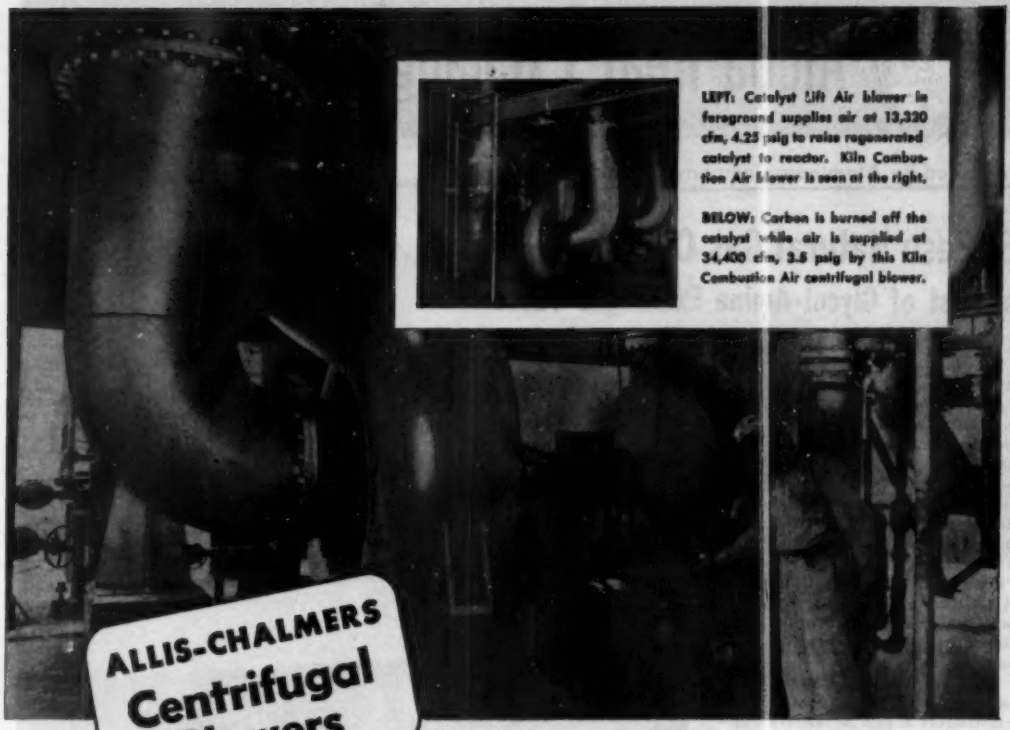

LEFT: Catalyst Lift Air blower in foreground supplies air at 13,320 cfm, 4.25 psig to raise regenerated catalyst to reactor. Kiln Combustion Air blower is seen at the right.

BELOW: Carbon is burned off the catalyst while air is supplied at 34,400 cfm, 3.5 psig by this Kiln Combustion Air centrifugal blower.

ALLIS-CHALMERS Centrifugal Blowers

Help New Cracking Methods

AS CRACKING METHODS IMPROVE, more centrifugal blowers are being employed. The Allis-Chalmers single stage blowers seen here are essential to the three new Thermofor Catalytic Cracking units installed by the Magnolia Petroleum Co. at Beaumont, Texas.

Placed "on stream" last Fall, a total of six turbine-driven A-C blowers provide Kiln Combustion and Catalyst Lift Air in the Blower Room of the new catalytic structure.

The high efficiency impellers are of special totally enclosed, backward flow design. This covered design makes the impellers independent of tolerance variations; the backward flow design gives good pressure, volume and horsepower characteristics.

High strength and long life is assured by all welded, alloy steel impeller construction and pressure lubricated sleeve and thrust bearings. Cast iron casing increases rigidity and decreases noise level.

For this kind of specialized design . . . or for standard high quality, thoroughly tested air and gas handling equipment . . . call your nearest A-C office or write direct to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3447

ALLIS-CHALMERS

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Power, Electrical, Processing Equipment for Petroleum Industry

TURBINE-GENERATORS | BLOWERS and COMPRESSORS | TRANS-FORMERS | UNIT SUBSTATIONS | MOTORS—TEXROPE DRIVES-CONTROL | CENTRIFUGAL PUMPS

ALCOA

Rearmament needs severely limit the manufacture of aluminum heat exchanger tubes. But we realize that the purchase of refinery and processing equipment requires long study of economic and performance factors. That is the reason for this message.

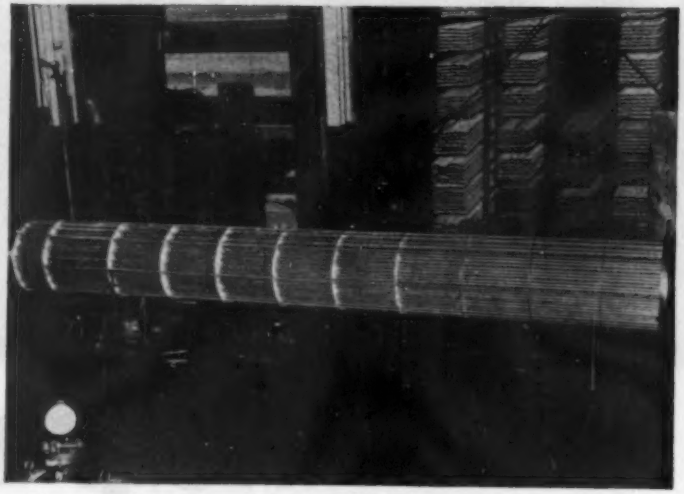
Published by Aluminum Company of America

El Paso Natural Gas Company Saves ⅓ in Cost of Glycol-Amine Exchanger Tubes

About three years ago, the Fluor Corporation started investigation in corrosion problems occurring with steel exchanger tubes in gas-treating plants utilizing Fluor's glycol-amine process. They conducted extensive research to find suitable replacements for steel. (Results of these tests were reported in the April, 1950, and February, 1951, issues of "Petroleum Refiner" Magazine.) Aluminum and 4-6 cr., ½ moly. steel tubes were most economical of the corrosion-resistant materials tested.

So when Fluor Corporation was selected to engineer glycol-amine exchangers at one of the large new plants of El Paso Natural Gas Company, they recommended Alcoa 3S-H14 aluminum tubes for the service. These tubes cost 30 per cent less than seamless mild steel and 60 per cent less than 4-6 cr., ½ moly. steel. Fabrication of the units was done by Griscom-Russell.

Aluminum heat exchanger tubes have been so successful in resisting corrosion in glycol-amine plant service that over 100,000 pounds of aluminum are now used in that service. Experimental work has indicated over one year of service with no sign of corrosion. In handling, shipping and fabricating costs, the aluminum tubes saved 200,000 pounds over the heavy metal tubes they replaced. Their greater ductility permits easier roll-in.



ALCOA OFFERS BOOKLET

This 24-page booklet will answer many of your questions about Alcoa Tubes. It covers fabrication techniques, alloy selection, chemical and petroleum applications. It describes tube cleaning, inhibitors, cathodic protection. It contains complete information on fluid flow and heat transfer. There are formulas, tables and specification data. Write for your free copy today. ALUMINUM COMPANY OF AMERICA, 1864-L Gulf Bldg., Pittsburgh 19, Penna

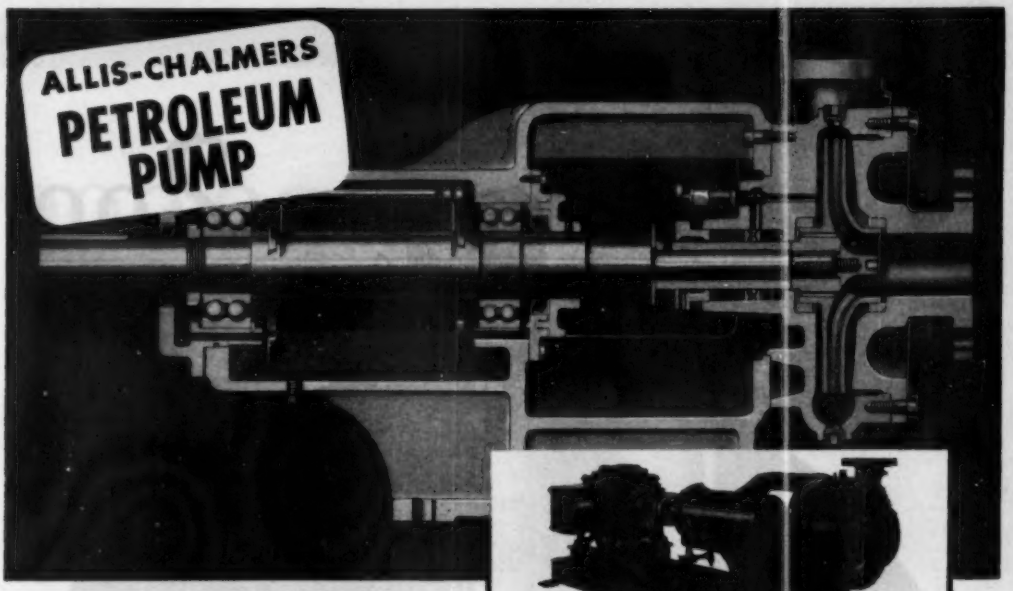
THESE APPLICATIONS ARE NATURALS FOR ALUMINUM TUBES:

Petroleum

Condensers handling hydrocarbon fractions such as gasoline, naphtha, gas, oil, etc.
Vapor recovery condensers
Lube oil coolers
Natural gas compressor aftercoolers
TCC overhead condensers
Recompressor aftercoolers
Hydrogen sulfide gas coolers
Furfural condensers and heat exchangers
Propane chilling
Wax sweaters
Lean oil—rich oil exchangers
Amine solution coolers
Glycol-amine solution coolers and heat exchangers.

Chemical

Butanol
Ethanol
Ethylene Glyco.
Glycerin
Hydroabietyl
Isopropanol
Methanol
Phenol
Propylene Glycol
Acetaldehyde
Formaldehyde
Furfural
Heptaldehyde
Acetic acid
Butyric acid
Stearic, Palmitic, Maleic Oleic acids
Naphtha
Ricinoleic acid
Acetanilide
Ammonia
Hydrogen Cyanide
Nitric acid (concentrated)
Pyridine
Hydrogen Sulfide
Benzene
Dichlorobenzene
Gasoline
Gelatin
Hydrogen Peroxide
Turpentine
Xylene



NEW

Specially Designed for Processing Operations

★ Choice of Materials
★ Oil Lubricated Bearings
★ Temperatures to 500° F.
★ Sizes to 1200 GPM, 250 Ft Head
★ Stuffing Box or Mechanical Seal

LONG LIFE, high efficiency, easy maintenance; you get them all from this new Allis-Chalmers Petroleum Pump. A wide choice of materials plus application engineering by men who know how to select the right material for your job means longest possible parts life and low maintenance costs no matter what you pump.

There is plenty of room between pump and pedestal for easy maintenance but rigidity has not been sacrificed. Maximum interchangeability of parts between sizes keeps parts inventory low.

ONE DEPENDABLE SOURCE

Allis-Chalmers can supply you with a complete pumping unit—pump, motor, drive and control — all of coordinated design and manufacture and all mounted on a rigid base ready to install.

To get more information on this new Allis-Chalmers Petroleum Pump, call your Allis-Chalmers Authorized Distributor or District Office. Or write to Allis-Chalmers, Milwaukee 1, Wis. for Bulletin 52B7638.

A-3459

Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

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Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

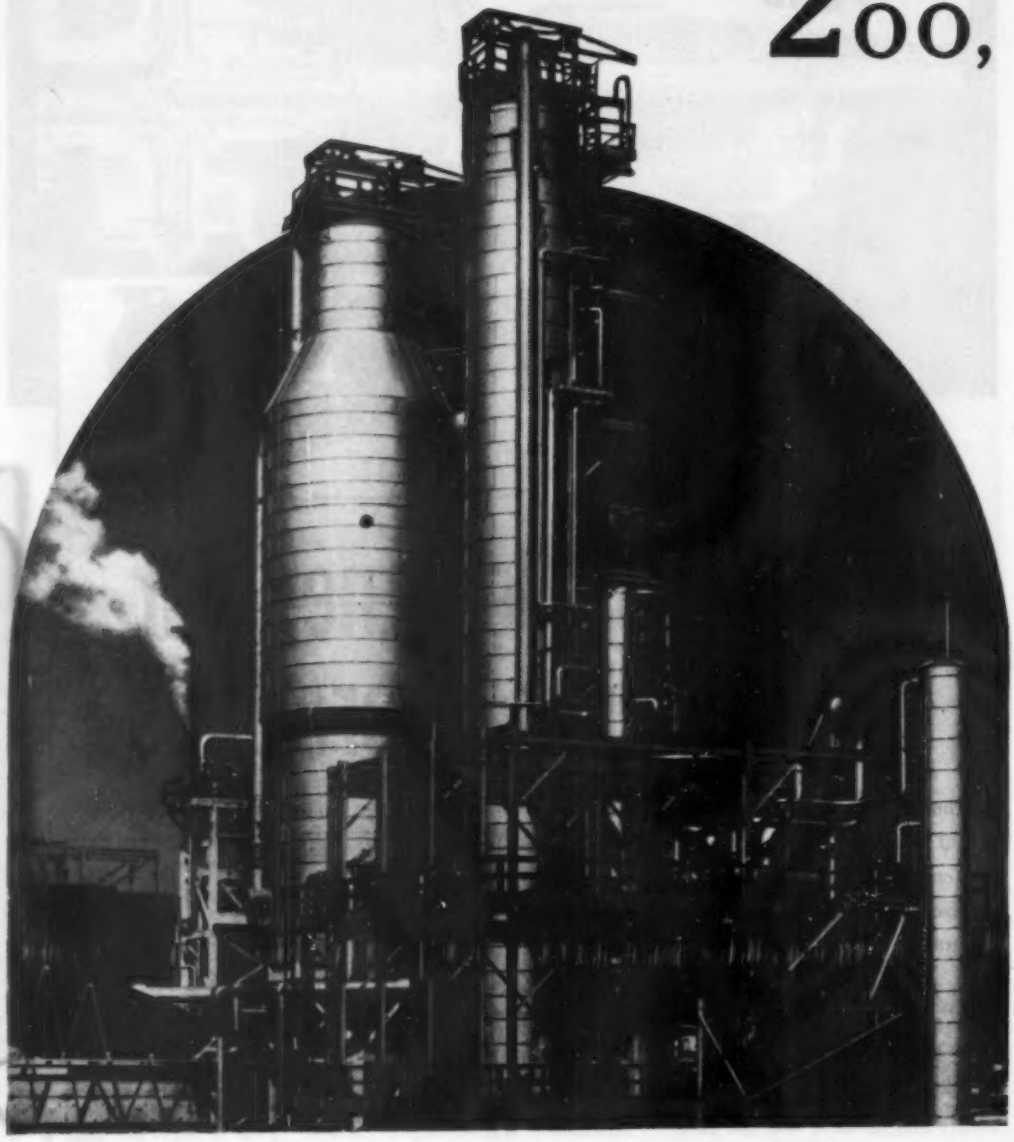
MOTORS — ½ to 25,000 hp and up. All types.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

ALLIS-CHALMERS

200,



OOO,OOO GALLONS PER DAY

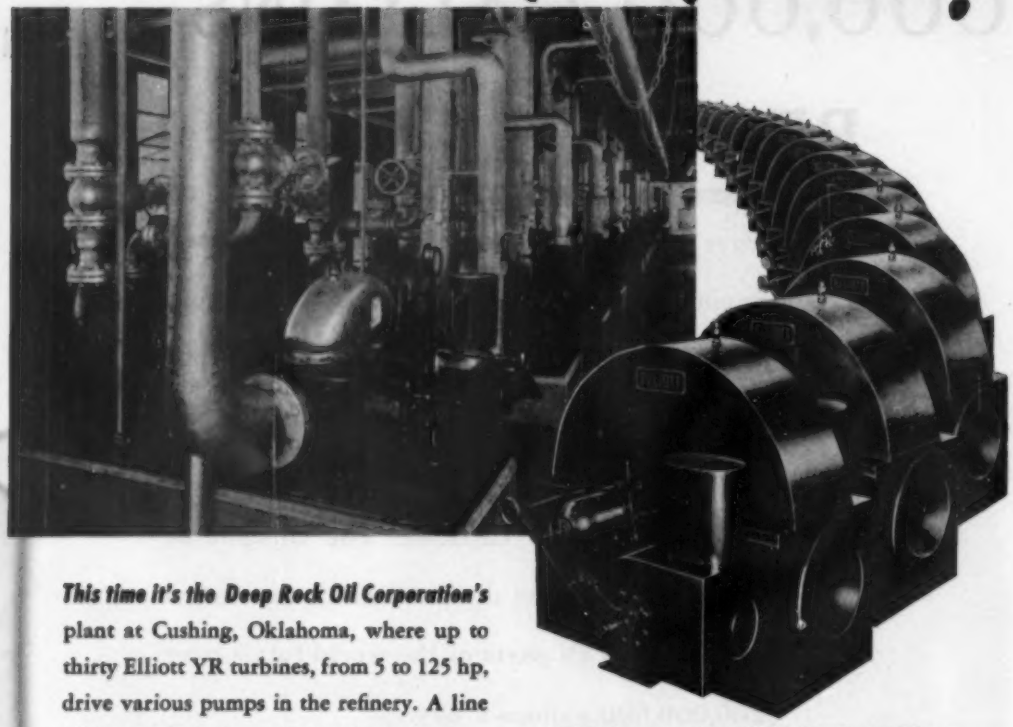
The Badger Process Division of Stone & Webster Engineering Corporation has broad experience in distillation. This experience ranges from the design and construction of small laboratory units processing a few gallons a day to units of 115,000 BPSD capacity. The thruput of all distillation units designed and constructed for clients in all parts of the world totals over 200,000,000 gallons a day.

BADGER PROCESS DIVISION
OF STONE & WEBSTER ENGINEERING CORPORATION

BOSTON NEW YORK
LONDON E. B. Badger & Sons (Great Britian) Ltd.

Process Engineers and Constructors for the Petroleum, Chemical and Petro-Chemical Industries

Again it's Elliott Turbines *for reliable pump drive!*



This time it's the Deep Rock Oil Corporation's plant at Cushing, Oklahoma, where up to thirty Elliott YR turbines, from 5 to 125 hp, drive various pumps in the refinery. A line of these units is shown in the photo above.

Low cost maintenance is well served by standardizing on these hardy turbines. With only five frame sizes for the entire capacity range, and with various governor and valve parts similar throughout, the inventory of replacement parts can be cut way down.

With the men whose job it is to keep things going Elliott turbines are pretty generally regarded as among the greatest worry-eliminators in the refinery. Bulletin H-16 tells why. Your request brings it.

HALF CENTURY OF POWER PROGRESS 1901 EL CO 1951

H-734

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If YOUR JOB INVOLVES

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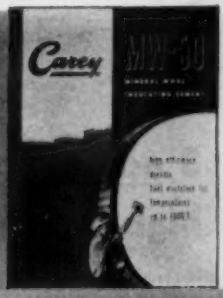
- processing operations
- refinery construction or maintenance...

You need this helpful literature!

Asbestos pipeline felt data book...

a discussion of protective coatings for pipelines by a competent corrosion engineer. Covers the fundamentals of low cost, dependable pipeline protection. Timely, informative, fully illustrated.

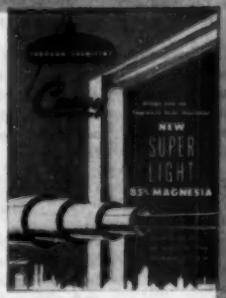


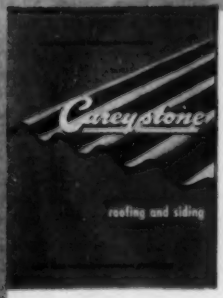
Carey MW-50 data book...

describes the most modern method for insulating all types of heated equipment having temperature ranges up to 1600°F., and gives details for applying insulation on irregular or hard-to-reach surfaces.

Super-Light 85% magnesia data book...

description, specifications and recommended uses for a new, improved insulation in precision-sized monolithic blocks, molded pipe coverings and cements.





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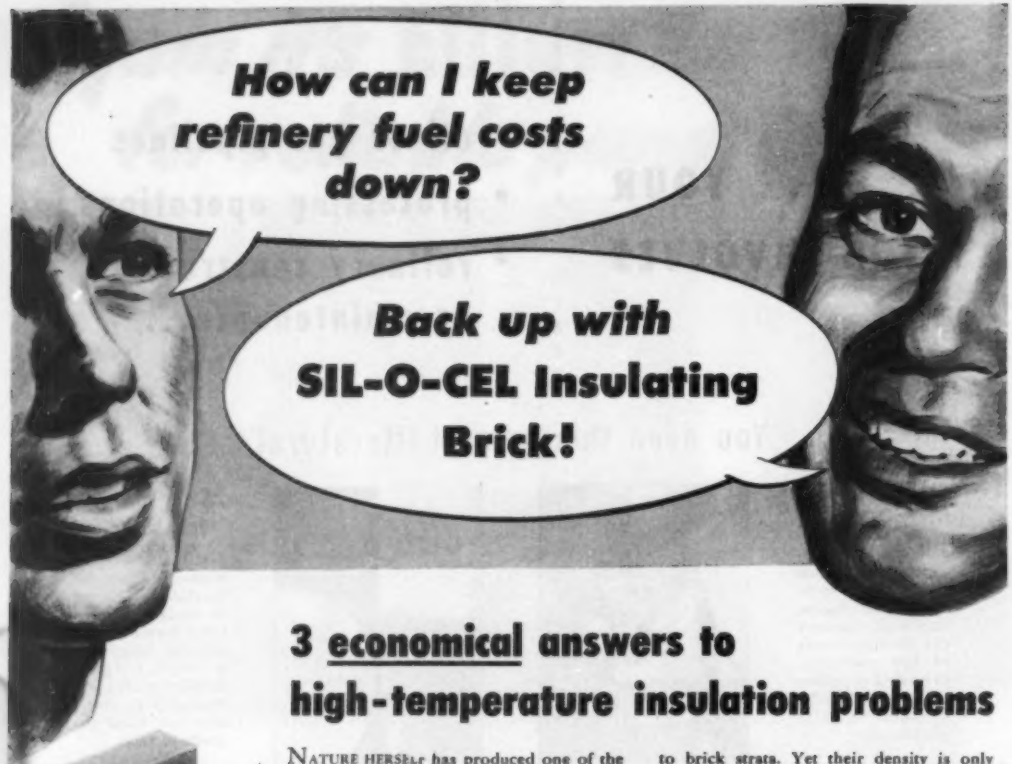
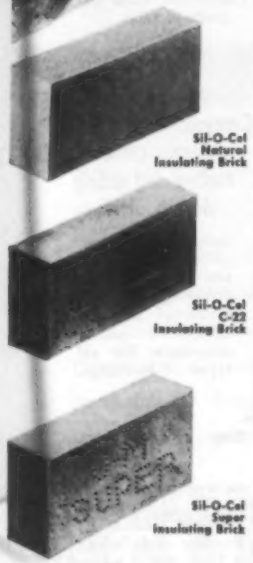


3 economical answers to high-temperature insulation problems



NATURE HERSELF has produced one of the most effective high-temperature insulating materials ever discovered—diatomaceous silica, from which Sil-O-Cel® Insulating Brick are made.

These insulating brick are used for back-up insulation behind fire brick or insulating fire brick linings in boilers, stills, stacks, reactor chambers, regenerators, heaters, flues, retorts, and other types of high-temperature equipment.

Sil-O-Cel Insulating Brick have excellent insulating qualities combined with high load-bearing characteristics and light weight.

Made in all standard shapes of the 2½ in. and 3 in. series, Sil-O-Cel Insulating Brick are produced in three basic types:

SIL-O-CEL NATURAL INSULATING BRICK
for temperatures to 1600F

Quarried directly from one of the world's purest deposits of diatomaceous silica, these insulating brick have a conductivity of only 0.79 Btu in./sq ft/F/hr at 1000F mean temperature, with heat flow perpendicular to brick strata. Yet their density is only 30 lb/cu ft. Cold crushing strength, 400 psi.

SIL-O-CEL C-22 INSULATING BRICK
for temperatures to 2000F

Ideal where high load-bearing properties are needed, this type of Sil-O-Cel is calcined, and has a cold crushing strength of 700 psi. Conductivity is 1.88 Btu in./sq ft/F/hr at 1000F mean temperature. Density, 38 lb/cu ft.

SIL-O-CEL SUPER INSULATING BRICK
for temperatures to 2500F

A calcined insulating brick for unusually high temperatures. In many cases, it is also possible to save on construction costs by reducing the thickness of fire brick or insulating fire brick when backed with Sil-O-Cel Super Insulating Brick. Conductivity is 1.95 Btu in./sq ft/F/hr at 1000F mean temperature. Density, 40 lb./cu. ft. Cold crushing strength, 300 psi.

For further information, write to Johns-Manville, Box 290, New York, N. Y. In Canada, write 199 Bay St., Toronto 1, Ont.

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PETROLEUM CHEMICALS DIVISION

NEWS

November ★ One of a Series of Interest to the Petroleum Industry ★ 1951

WHAT IS TEL?

Motor fuel antiknock compound is made by blending various halogen carriers, dye and kerosine with tetraethyl lead.

When used in an internal combustion engine, tetraethyl lead by itself would form nonvolatile decomposition products which would deposit on the cylinder head and other surfaces of the combustion chamber. To reduce the deposition tendency of these products by increasing their volatility through chemical reaction, scavengers in the form of ethylene dichloride and ethylene dibromide are added. The proportion in which these scavengers are employed is determined initially in laboratory engines and proof-tested in extensive road tests in commercial equipment under actual operating conditions.

Sufficient dye is added to give a distinctive color to the mix as all the other ingredients are colorless or water white. Kerosine in limited amount is used as a standardizing agent to insure uniformity of TEL content in the mix. It is a stable product up to 330°F. but begins to decompose above that temperature.

Du Pont GAS GUARD prevents fuel line freezing

Du Pont Gas Guard is another product designed to help motorists get better car performance. Gas Guard helps prevent ice from forming in gasoline lines of autos, trucks and tractors.

Cold-weather engine stalling, spitting and sputtering due to the presence of water in gasoline can also be prevented by Du Pont Gas Guard. By keeping the system ice-free, it contributes to quicker starting and smoother engine performance, even in sub-zero weather.

One pint of Du Pont Gas Guard in 15 gallons of gasoline, for example, will prevent freezing of as much as 10 ounces of water at 30° below zero F. During moderate freezing and zero weather, a pint of Gas Guard every 1,000 miles of driving will give adequate protection.

It is also highly effective as an antifreeze in diesel fuels. At −24°F., one pint of Gas Guard in 10 gallons of diesel fuel will keep 14 ounces of water from freezing, thus preventing crystals from clogging the jets.

It is harmless to the carburetor, fuel pump and other engine parts when used as directed. Du Pont Gas Guard is distributed in pint cans through service stations, garages and car dealers.

Du Pont Test Fleet Accumulates Deposit Data Under Actual Traffic Conditions

WHEN Du Pont engineers undertook a study of engine deposits and their effect on octane requirement, they determined to make certain that the findings would be of practical value to refiners. To study only the deposits built up in laboratory engines was not enough.

READY FOR A DAY'S TEST RUN, the four Oldsmobiles and four Pontiacs used in the deposit studies are shown with their drivers in front of the Du Pont test fleet garage.

These engineers wanted the study to be truly representative of the deposits accumulated in the average car, powered by average gasoline, under average traffic conditions. But how could they be sure the deposits from any given auto engine would be representative? The Du Pont test fleet provided an answer.

A test course approximating typical highway and city driving conditions was set up. About 64% of the course was through downtown Philadelphia traffic. The remainder over nearby country roads.

Starting with deposit-free engines, eight cars were driven over the course daily until a total of 8,500 miles was recorded on each car. Four of the cars were 1950 Oldsmobile 98's with hydromatic transmissions. The other four were 1947 Pontiac 8's with 1948 engines and standard transmissions.

Before starting the test, each car was road-checked for gasoline mileage, acceleration time and octane requirement. The engines were not "doctored" in any way. Each was tuned up according to the manufacturer's standard specifications . . . and kept that way until completion of the test. To assure uniform operation, distributor settings were constantly checked throughout the test.

The fleet was set up in pairs of cars. Each pair used identical fuels and lubricants. This made it possible for the performance of one car to be checked against that of its identical mate . . . an additional assurance of uniform engine performance.

The cars were operated as a group, although no attempt was made to maintain exact formation in heavy traffic. The city course was covered several times each day. This helped to vary the traffic density conditions and the amount of start-and-stop driving . . . with each car encountering about the same conditions during a day's run.

The cars were equipped with recording tachographs to give an accurate account of their individual operations.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED

Test Fleet

These instruments helped supply many valuable statistics. For example, they showed that during a 5-day period the average number of stops per car per 8-hour shift was 328. And all these stops occurred in an average of 101 miles of operation.

Sixteen drivers, working two shifts, participated in the test. To control the driver effect, the men were alternated so that each car was driven approximately the same time and mileage by all drivers.

A driver-leader was in charge of each shift. The leaders were responsible for the safe performance of the fleet in the field.

Driving safety and courtesy is emphasized in all Du Pont test fleet operations. In addition to turning in an excellent safety record, the fleet drivers were able to help several motorists in trouble on the road. For example, since all test cars carried fire extinguishers, the Du Pont drivers were in a position to put out a number of highway auto fires which might otherwise have been both hazardous and damaging.

At 8,500 miles the test car engines were taken down and the quantity and composition of their deposits investigated. As was expected, much

THE TWO DRIVER-LEADERS are also trained mechanics. Here they are inspecting the torn down engines of the eight cars used in the recent Du Pont deposit studies.

new information was gained from the test. This, along with other data, was evaluated at the Du Pont Petroleum Laboratory and the results are now available to refiners in a paper recently published. This paper was presented by L. F. Dumont of the Petroleum Laboratory staff at the June S.A.E. meeting in French Lick, Indiana. Reprints of the paper with the title, "Possible Mechanisms by which Deposits Accumulate and Influence Knock" are available on request.

Du Pont test fleets constantly work on road tests of this type. In addition to the one described above, a 5,200 mile test with "dirty" fuel has just been completed. And another deposit study is now being made with the Du Pont heavy-duty truck fleet in El Monte, California.

Assistant Director of Petroleum Laboratory

W. E. BETTONEY

W. E. BETTONEY was appointed Assistant Director of the Du Pont Petroleum Laboratory in June of this year. In this capacity he directs work on combustion chamber deposit studies and other petroleum research projects. He is also in charge of test fleet operations. Previous to this assignment, Bettoney headed the Engineering Division of the Laboratory.

He came to Du Pont in 1946 from Universal Oil Products. With the Chrysler Corporation during World War II, he worked on the development of B-29 engines at the Dodge Chicago plant. Before this, Bettoney spent three years as a government test engineer on full-scale experimental airplane engines at Wright Field.

He graduated from the University of Maine with a B.S. in mechanical engineering and did graduate work at Columbia and New York Universities.

New TEL Blending Chart for Laboratory Convenience

A reference chart for blending Du Pont Tetraethyl Lead Compound—Aviation Mix with small quantities of gasoline is now available to refiners. It was prepared by Du Pont to aid laboratory personnel in the leading of test fuels and samples.

In table form, the chart shows the number of milliliters of Du Pont Aviation Mix required for fuel samples from 1 to 20 liters and from 0.1 to 100 gallons. Any desired concentration from 0.1 to 6.0 ml TEL/gal. can be prepared from the table.

In addition, information on the properties, composition, conversion factors and dye concentrations of Du Pont TEL Aviation Mix is included on the reverse side. Ask the nearest Du Pont district office or write direct to Du Pont for your copy.

MOVIES AVAILABLE

Prints of the following Du Pont films are available to oil companies for training and public relations purposes. They may be borrowed or purchased. Address request to nearest Petroleum Chemicals Division district office.

Pipeline on Wheels—A 26-minute, full-color movie on tank truck safety. Suitable for both training and public relations purposes.

What Makes A Gasoline Good—An 18-minute cartoon movie in color. Presents the story of how high quality gasoline is made in easy-to-understand form. Ideal for dealer training meetings.

In addition to the above, Du Pont makes available a special library of films of particular interest to the petroleum industry.

DU PONT

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. . . through Chemistry

Petroleum Chemicals

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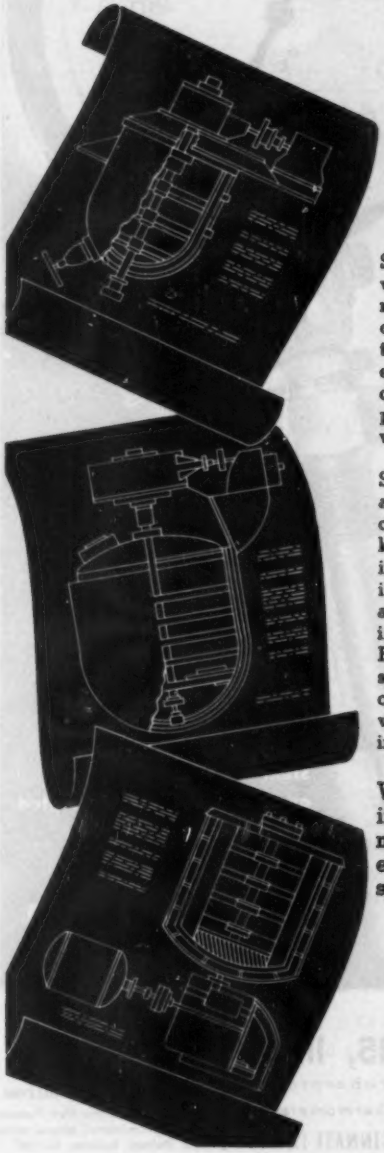
DEPENDABLE

Grease Kettles by STRUTHERS WELLS



Struthers Wells will engineer mixing kettles for greases or other heavy viscous materials—to your most exact specifications and requirements. Kettles can be furnished with agitating drive at top or bottom—open, closed or pressure top—jacketed or unjacketed—in any metal or alloy desired. Advanced design provides proper seals where pressure top is used.

Sweep and paddle arms are pitched to create flow of material throughout kettle, preventing stratifying of mix. Scraper blades insure positive scraping action on about 98% of inside surface of mixer. Bottom bearing is accessible for easy maintenance or replacement. Flush type valve at bottom furnished in sizes from 1" to 8"

Write for proposal on intricate or standard mixing equipment—engineered for your specific needs.

Struthers Wells

STRUTHERS WELLS CORPORATION

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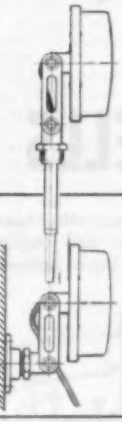
mercury actuated Dial Thermometers

now in three types to suit any requirements

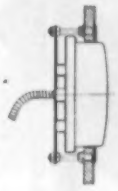


1 Rigid Stem Dial Thermometer

Rigid stem tapered bulb, interchangeable with standard industrial thermometer separable socket.

2 Wall Mounted Dial Thermometer

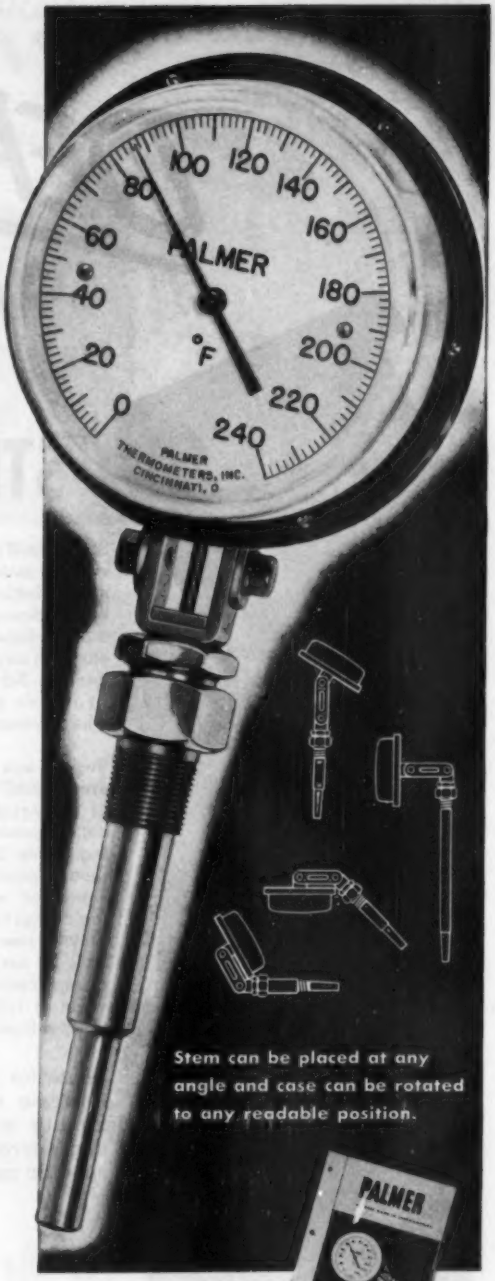
Wall mounted dial thermometer with flexible connecting armor. Case adjustable to easy reading position.



3 Flush Mounted Dial Thermometer

Flush mounted style for panel mounting with flexible connecting armor.

All three types have a full 4½" dial Face



Stem can be placed at any angle and case can be rotated to any readable position.

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensation. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

SEND FOR THIS BULLETIN

For details on the New Palmer Dial Thermometer, please write for Palmer Bulletin 51-129.

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Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

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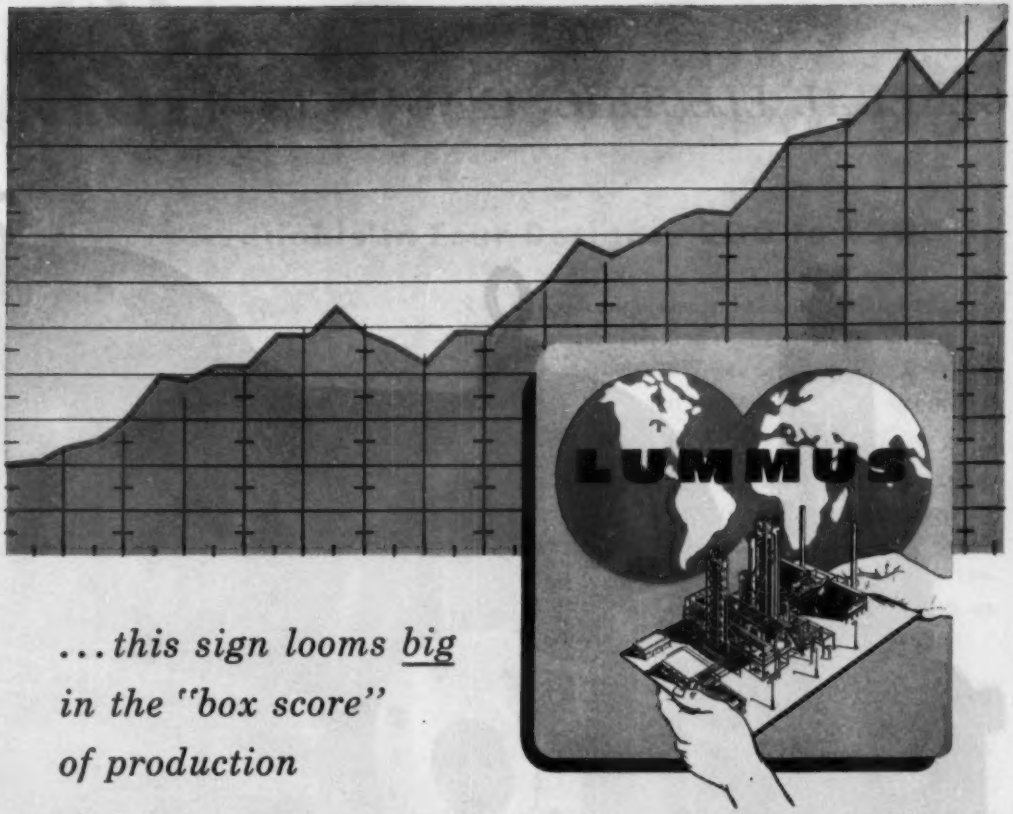

...this sign looms big in the "box score" of production

For better than sixty years the Lummus sign has meant *excellence* in the designing, engineering and constructing of petroleum refineries and chemical plants. It means the same today. And you need take only a short mental jump to see its importance in the days ahead, as oil refiners and chemical producers are called upon to break and re-break production records.

Let's look at a partial "box score" of Lummus' current contributions toward these world-wide objectives. In the U. S. and abroad, Lummus is engaged in seven catalytic cracking projects—as well as in providing alkylation facilities —to meet the record-breaking demand for superior aviation and motor fuels.

Lummus currently has seven ethylene units "on the go" in Europe and the U. S.—plants which will operate with telling effect in supplying a vital basic raw material. One project—the Gulf Oil Corporation unit at Port Arthur, Texas—is the world's largest ethylene unit. It will produce nearly 2½ billion cubic feet yearly, increasing total U. S. production of ethylene by about 12%.

Isn't this a reassuring record for you to tie to? It strongly suggests that you think of Lummus first in your plans for petroleum refinery or chemical plant expansion.

THE LUMMUS COMPANY

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DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

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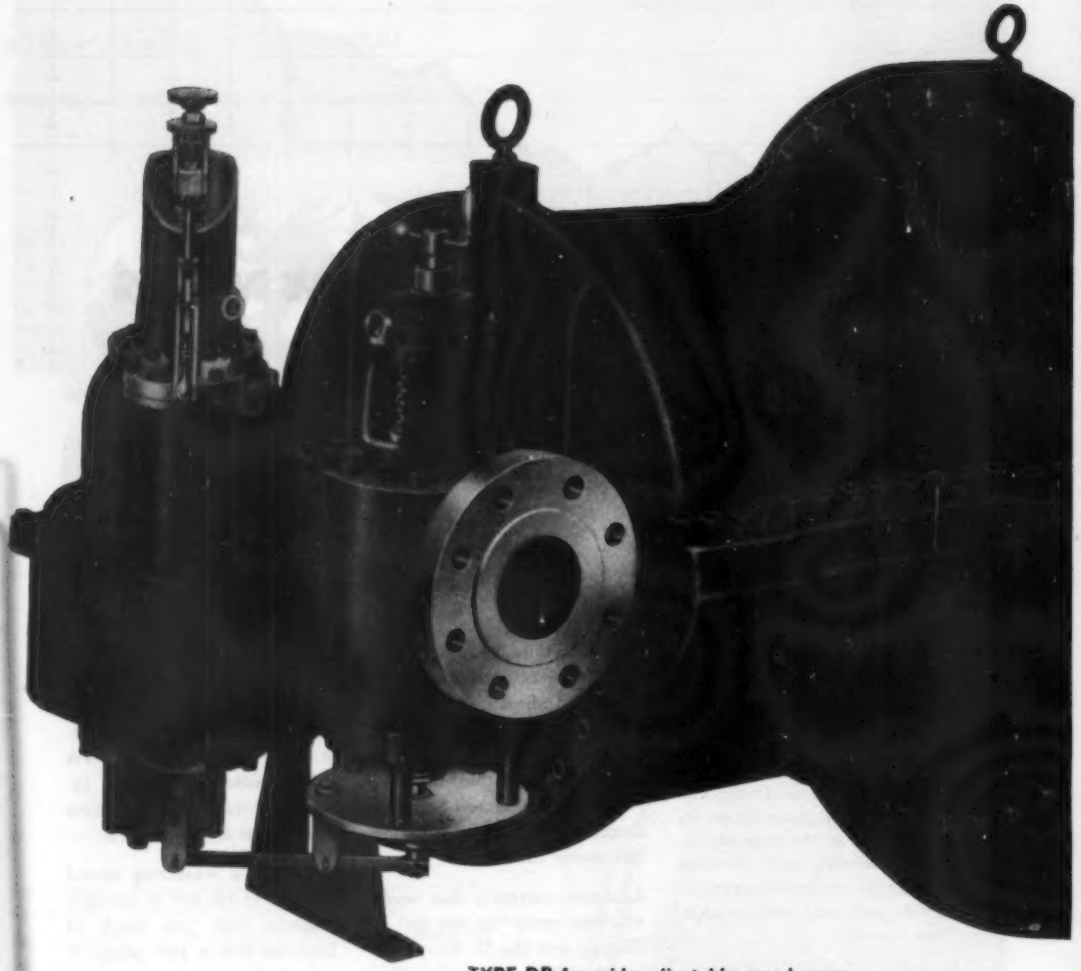
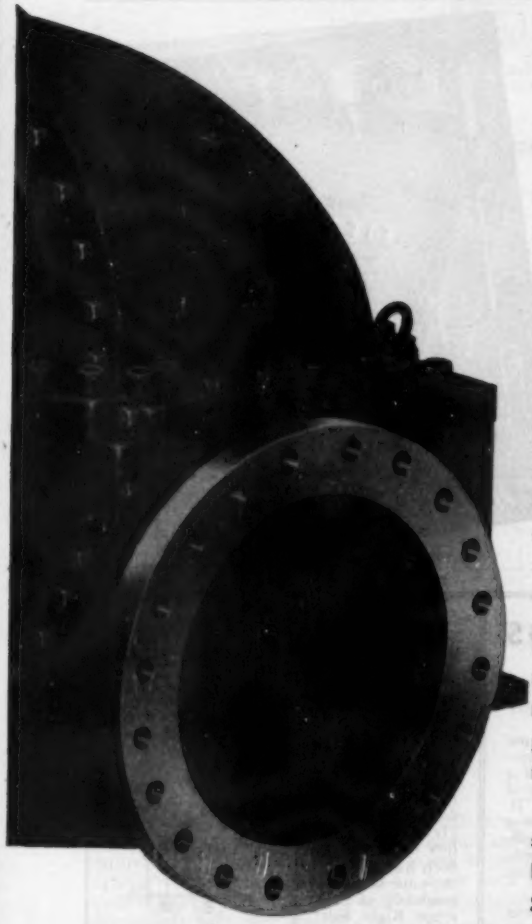


TYPE DR for wide adjustable-speed range

Multi-Stage Turbines

Available in Four Designs—200 to 5000 hp



Now in production! General Electric's completely new, multi-stage turbine drives . . . designed to give you maximum mechanical power for every fuel dollar . . . available to meet any mechanical drive application where efficiency and reliability are "musts."

FOUR NEW TYPES—The DP, DR, DRV, DRVX—incorporate the newest ideas in improved turbine design. Four different governing systems give you a wide selection of performance ratings for either condensing, noncondensing or automatic extraction applications.

NEW FEATURES that spell increased economy and reliability are built into General Electric's new multi-stage turbines. A completely new sectional valve gear, for instance, gives you greater efficiency for part load operation. Refinements in governing, lubrication and steam chest design make these the finest mechanical-drive turbines General Electric has ever produced.

A NEW TECHNIQUE of manufacturing from standard, interchangeable patterns promises you savings in initial investment and shortened delivery time. You get a custom turbine, designed for your job, built from standard parts.

Get the full particulars on these brand new multi-stage turbine drives. Write for your copy of our new bulletin, GEA-5580, "G-E Multi-Stage Turbine Drives." Section 252-52, General Electric, Schenectady 5, N.Y.

253-52

GENERAL ELECTRIC

NOTES for Process Engineers

C. H. Wheeler OF PHILADELPHIA

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YOU MAY BE ABLE TO LOWER YOUR COOLING COSTS

INVESTIGATE C. H. WHEELER STEAM JET VACUUM COOLING SYSTEMS

Where your chilled water temperature requirements are 35° to 65°F and you have steam available, C. H. Wheeler engineers are prepared to submit recommendations on equipment for the lowest operating cost consistent with reliability and the necessary marginal factors on performance. In addition to the low first cost of these units, the absence of moving parts (with the exception of pumps) results in extremely low maintenance costs.

In refineries, the cooling of absorption oil to improve recovery of light hydrocarbons, and the chilling of cooling water required for deethanizer condensers used in the manufacture of liquefied propane gas, are typical applications of C. H. Wheeler steam jet vacuum cooling systems. Cooling is by the well known principle of Flash Evaporation, using live or exhaust steam that you may be presently wasting.

A 36-page book on C. H. Wheeler Steam Jet Ejectors will be mailed you on request. It contains useful data and will augment your store of knowledge on the subject.

$13,500 ESTIMATED SAVINGS

IN 6 YEARS WITH A C. H. WHEELER COOLING TOWER

A C. H. Wheeler customer worked out his own engineering estimate of the savings assured through the purchase of a 3 cell C. H. Wheeler Cooling Tower of 12,500 GPM capacity. He chose C. H. Wheeler over a competitive 2-cell tower costing $10,000 less. The greater efficiency of C. H. Wheeler tower engineering results in estimated yearly operating savings of $2,261.

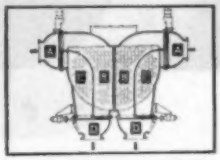
The formula employed by the customer and a tabulation of his figures has been reproduced for your appraisal. This, together with Catalog 145, will augment your knowledge of cooling tower operation. A request on your company letterhead will bring them by return mail.

Be sure to call a C. H. Wheeler representative early in your cooling tower plans. He shows you where to check for features of quality.

"REVERSE FLOW" CONDENSERS

Reduce Operating Costs because they are SELF-CLEANING

By an arrangement of electrically or hydraulically controlled sluice gates the flow of water through the condenser tubes is reversed. Refuse is flushed down the discharge in minutes, thus saving hours of downtime for hand cleaning. Here is how it works:

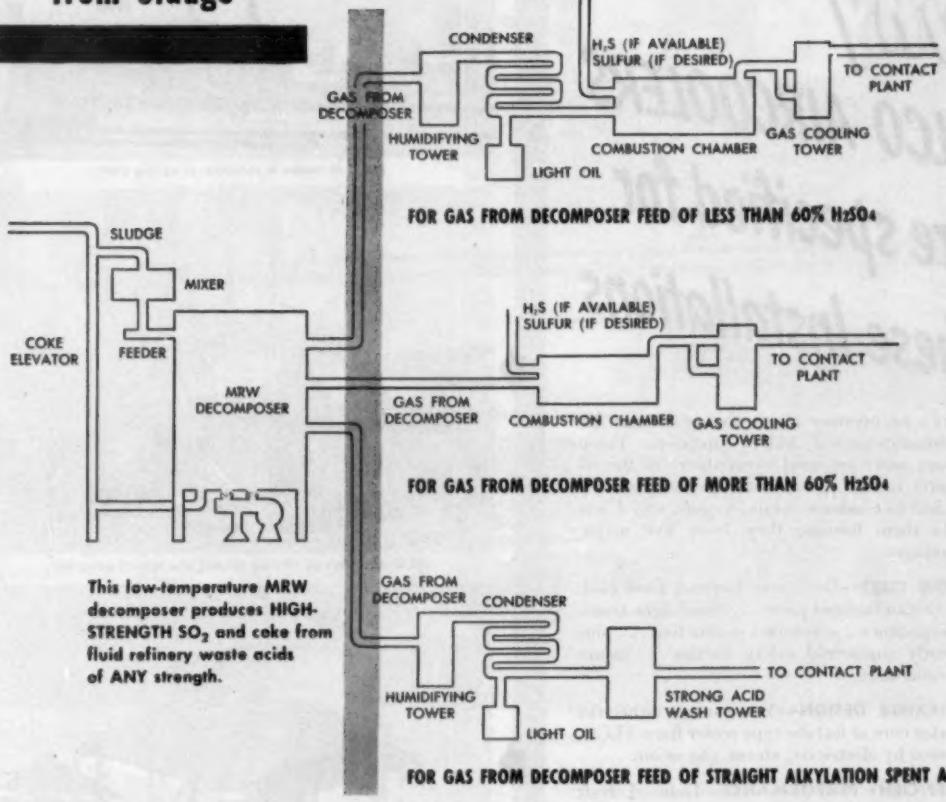


Both halves work the same but independently of each other. Right Side: (Normal flow) Water enters divided water box at valve chamber A, with lower port open. It flows through pass C to end of condenser, back through pass B and out through left port of D.

Left Side: Flow is reversed: Valves at inlet A and discharge D are changed to permit water to flow through B and back through C in the opposite direction, then out through D.

C. H. WHEELER MANUFACTURING CO., 1818 SEDGLEY AVE., PHILADELPHIA 32, PA.

How to make white sulfuric acid from sludge



Clean, white sulfuric acid, of any desired strength, can be made from your refinery sludge or H_2S—or both together—with a Monsanto-Ross-Wilde sludge recovery unit. This unit may operate with your present contact sulfuric acid plant or, if you have no plant, Monsanto will design your sludge recovery and sulfuric acid units as a single project.

In addition to sulfuric acid, these units recover oil from some type of sludge that can be refined into salable products.

Community relations are improved by eliminating stream and atmospheric pollution. Urgently needed tank cars, now used to carry away sludge and to return reclaimed acid, will be available for other purposes once your Monsanto-Ross-Wilde sludge recovery unit is in operation.

Because of present sulfur shortage and the growing use of sulfuric acid, a Monsanto-Ross-Wilde sludge recovery unit should be a sound investment for the present and future.

At your request, and without obligating you, a Monsanto representative will visit your plant and estimate the cost of a Monsanto-Ross-Wilde installation. He will show you how much acid you can produce . . . how much you can save on waste disposal costs. Write, wire or telephone MONSANTO CHEMICAL COMPANY, Engineering Sales Department, 1776-L South Second Street, St. Louis 4, Missouri.

MONSANTO
CHEMICALS — PLASTICS

SERVING INDUSTRY . . . WHICH SERVES MANKIND

why ALCO AIRCOOLERS are specified for these Installations

There's no mystery about the preference for performance-proved ALCO Aircoolers. These efficient units are used everywhere by the oil industry to cool jacket-water, gas, engine lube oils, and to condense steam, vapors, etc. Users prefer them because they have five major advantages:

1. **LOW COST**—Goes way beyond first cost. ALCO standardized parts . . . broad heat-transfer experience . . . volume production . . . plus correctly engineered safety factors . . . insure *real* economies.

2. **FLEXIBLE DESIGN**—You can get either the radiator core or fintube type cooler from ALCO, powered by electricity, steam, gas or oil.

3. **EFFICIENT PERFORMANCE**—Induced draft design eliminates the chance of recycling hot air with a subsequent loss in heat transfer.

4. **EASY MAINTENANCE**—Fewer parts, easy accessibility and better wearing characteristics.

5. **QUICK INSTALLATION**—For fast field assembly, every part is marked and identified on assembly drawings so that no specialized labor is required.

Send now for free catalog, or call your nearest ALCO Sales Engineer at Beaumont, Chicago, Houston, Los Angeles, New York or Tulsa. Plants at Dunkirk, New York, and Beaumont, Texas.

ALCO Aircoolers in operation at cycling plant

ALCO Aircoolers on treating columns in a natural gas plant

ALCO Aircooler cooling jacket water for Diesel engines

ALCO

ALCO Products Division

AMERICAN LOCOMOTIVE COMPANY

In step with tomorrow—ALCO AIRCOOLERS, Heat Exchangers, Evaporators, Feedwater Heaters, Pressure Vessels, Pipe

WHEREVER ACCURACY COUNTS...

You Can Count on...

CLIMAX
BS&B
CONTROLS

SUN OIL COMPANY'S big, modern Natural Gas plant at Delmita, Starr Co., Texas —where 99% of the automatic valves and controls are Climax.

For control of pressures, temperatures, levels and flow—industries look to Climax Controls for the exacting reliability they require.

Accuracy is initiated at the BS&B Climax Controls division, where every control and valve must undergo rigid tests before delivery; and where engineers, metallurgists and laboratory technicians are constantly exploring and developing new materials, new methods, new and improved products, and new ideas.

In the Oil, Gas, Chemical and Petro-Chemical Industries, especially, the name "Climax" has become synonymous with efficiency and trouble-free performance.

The employment of Climax valves, controls, regulators or relays have in many cases eliminated manual operations, varied, increased or multiplied the functions of equipment, supplied additional safety factors and reduced the supervisory requirements. At BS&B headquarters a large Climax engineering staff is available to assist you with your problems. Your inquiries will be treated in strict confidence.

Write today on your company letterhead for latest issue of the Climax Controls Catalog.

BS&B

BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division, Dept. 60-F

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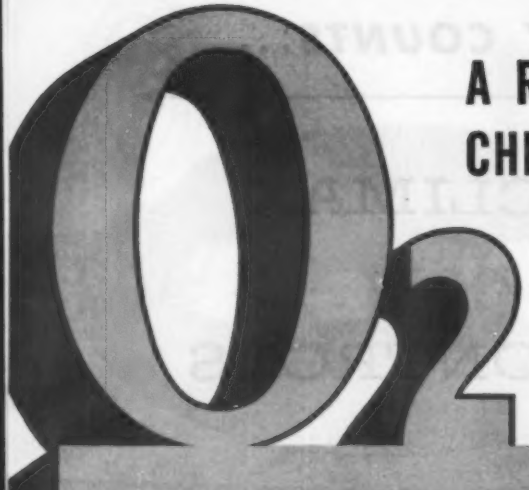

A REACTIVE AND IMPORTANT CHEMICAL "BUILDING BLOCK"

with constantly mounting applications in many industrial fields

CHEMICAL AND PHYSICAL PROPERTIES OF OXYGEN

Chemical Symbol	O_2
Atomic Number	8
Periodic Group	VI
Atomic Weight	16.00
Molecular Weight	32.00
Molecular Diameter	3.39×10^{-8} cm
Isotopes	16, 17, 18
Allotropes	Ozone (O_3)
Valence	2 and 6
Concentration in Dry Air	20.93%
Boiling Point (atm. pres.)	—183.1°C
Melting Point	—218.8°C
Critical Temperature	—118.8°C
Critical Pressure	49.7 atm.
Critical Density	0.430 gm/cc

Vapor Pressure at Various Temperatures:

Pressure mm. Hg	Temperature °C.
0.76	—219.8
7.60	—211.3
76.0	—200.6
190.0	—194.3
380.0	—189.0
760.0	—183.1

Latent Heat of Vaporization	1635.8 cal./mol. @ B.P.
Latent Heat of Fusion	106.0 cal./mol. @ M.P.
Heat of Reaction with Carbon (Coke)	97,000 cal./mol.
Heat of Reaction with Carbon (Graphite)	94,400 cal./mol.
Heat of Reaction with Hydrogen	68,317 cal./mol.

Boiling Points of O_2 - N_2 Mixtures: 1 atm. Pressure

O_2%	BP °K
90	87.7
95	88.9
98	89.9
99	90.0
99.5	90.1

Entropy:	T °K	Cal gm mole °K
1 Atm.	50	12.52
	100	40.56
	150	43.31
	200	45.36
	250	46.84
	273.1	47.75
	298.1	48.04

Molal Volume: 0° C, 1 atm. (g) 22,397 cc

Specific Gravity:
- @ 0° C (g) 1.429
- @ —182.5° C (l) 1.14
- @ —252.5° C (s) 1.426

Specific Heat:

BP to 25°C (g)	6.98 cal/gm mol.
—183° to —209°C (l)	12.62 cal/gm-mol.
—221.6°C (s)	10.74 cal/gm mol.

Coefficient of Thermal Expansion:

0° C to 100° C (g)	3.674×10^{-3}
—195° C (l)	4.10×10^{-3}

Compressibility Factor: PV — 1.0 @ 1 atm., 0° C

P, atm.	0°C	50°C	100°C	200°C
1	1.0000	1.1838	1.3674	
10	0.9913	1.1796	1.3661	
50	0.9569	1.1642	1.3630	
100	0.9234	1.1520	1.3651	
200	0.9140		1.4000	1.8190
300	0.9425		1.4530	1.8650
400	1.0015		1.5120	1.9610
500	1.1560		1.6220	2.0580

$\frac{C_p}{C_v}$ (atm. pressure)	0°C.	$\frac{C_p}{C_v}$
	15	1.401
	—76	1.415
	—181	1.45

Vandervaal's Constants: $a = 1.360$ (liter^2, atm. mole^{-2}); $b = 0.03183$ (liters, mole^{-1})

Solubility in Water:
- 4.89 cc in 100 cc @ 0° C
- 2.6 cc in 100 cc @ 30° C
- 1.7 cc in 100 cc @ 100° C

Viscosity:
- @ BP (g) 0.00736 CP
- @ MP (l) 0.883 CP
- @ 0° C (g) 0.0192 CP
- @ —193° C (l) 0.245 CP

Moisture Content of Saturated Oxygen .130 gm/ft^3 @ 0°C

Thermal Conductivity:

	cal. cm-sec- °C
0°C (g)	5.7×10^{-6}
—78.4°C (g)	4.29×10^{-6}
—191.4°C (g)	1.72×10^{-6}

Index of Refraction: —161°C (g) 1.221

Remember that oxygen is one of the least expensive elements available in pure form, and is finding increasing use in more and more fields. As supplier or user, remember that Chemical Plants builds complete production units in all commercial sizes—based on the processes of Gesellschaft fuer Linde's Eismaschinen, A. G.

CHEMICAL PLANTS DIVISION

BLAW-KNOX CONSTRUCTION COMPANY

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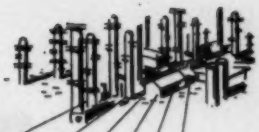
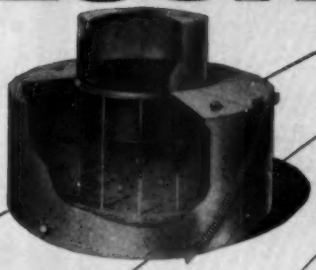
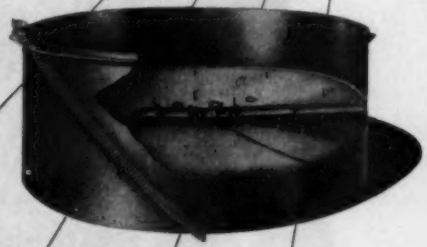
GRAVER

EXCLUSIVES

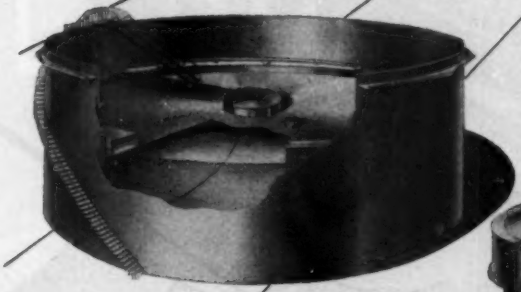




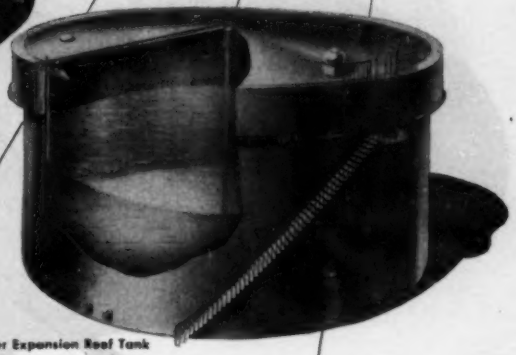
• Graver Vapor-Mizer



• Graver Double Deck Floating Roof Tank



• Graver Center-Weighted Floating Roof Tank



• Graver Expansion Roof Tank

These four Graver fabrications — each a patented design — are built not only to *conserve* but also to *preserve* the quality of the petroleum product. For this reason, the Graver principle of Conservation Control saves the volatile elements of gasoline, thus effecting economy and insuring motorists the same *high quality* that has been built into the motor fuel at the refinery!

GRAVER TANK & MFG. CO., INC.

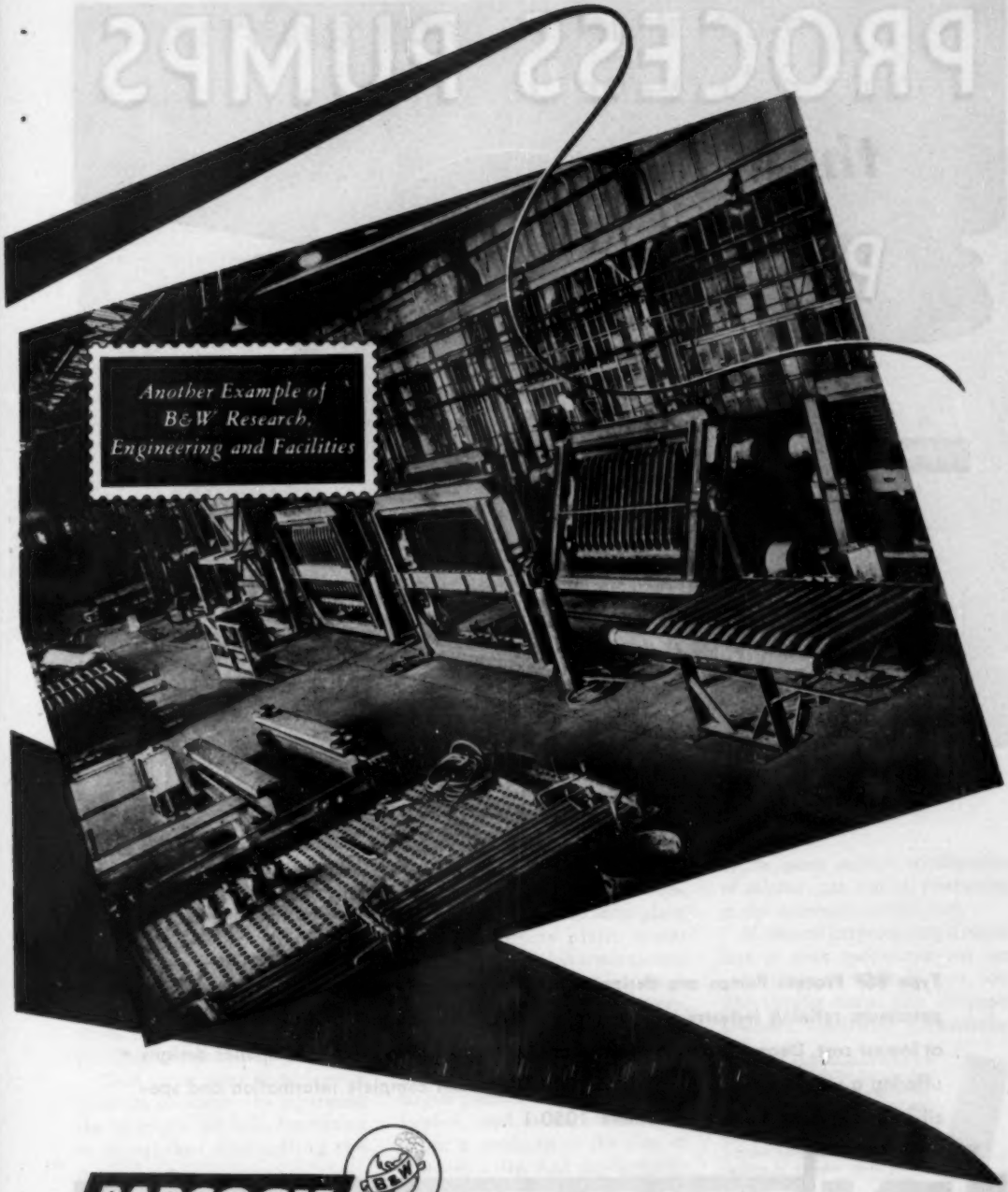
EAST CHICAGO, INDIANA

NEW YORK · CHICAGO · PHILADELPHIA · WASHINGTON
DETROIT · CINCINNATI · CATASAUQUA, PA.
HOUSTON · SAND SPRINGS, OKLA.

# of tube-fabricating know-how

Some 190,000 feet—over 1370 tons—of 5 to 27 per cent chromium steel tubing were skillfully joined by an entirely new technique of welding to form catalyst cases for dehydrogenation units in a butadiene plant. *All* operations on this record-size high-chrome fabricating job were performed in B&W's own shops. Operating temperatures range from 200 F to 1300 F.

It's this ability to work closely with designers and operators of such advanced process operations that distinguishes B&W from ordinary jobbing fabricators. Years of experience with the full range of industry's process equipment needs . . . joined with unexcelled facilities, ample research equipment and personnel for development work in numerous fields . . . help insure the dependability —and economy—of B&W Products.



BABCOCK & WILCOX

The Babcock & Wilcox Company, 85 Liberty Street, New York 6, N. Y.

S-4057

PROCESS PUMPS

PAY OFF

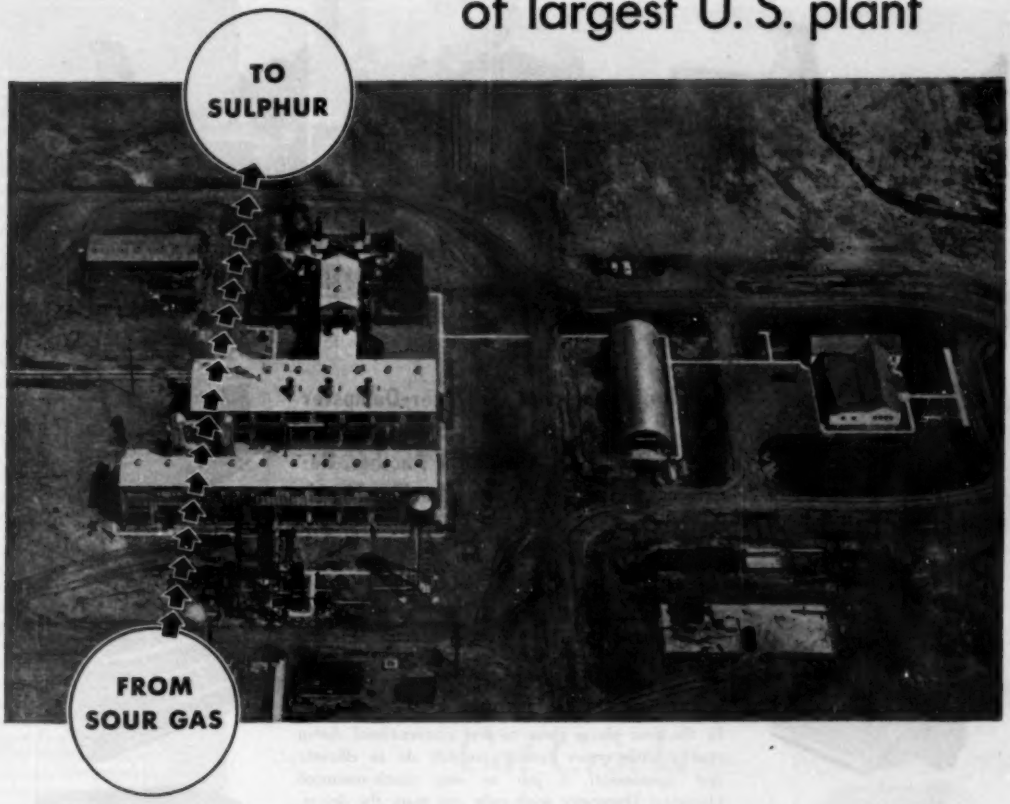
DEAN HILL PROCESS PUMP-(TYPE BSP)

The pay-off comes in top performance . . . in long service . . . in low maintenance cost . . . in dependable, year-after-year service.

Type BSP Process Pumps are designed for the tough processing applications of the petroleum refining industry. To assure you peak performance and highest efficiency at lowest cost, Dean Hill Process Pumps are built in 12 sizes, with 24 impeller designs offering a capacity range from 10 to 1000 GPM. Get complete information and specifications. Write today for Bulletin 1050-1.

DEAN HILL PUMP COMPANY

Girdler handles construction of largest U. S. plant



BEFORE this new Wyoming plant of the Texas Gulf Sulphur Company went in operation, large volumes of "sour" natural gas released at the wells of the Worland Oil Field had to be burned and wasted as the gas contained about 30% hydrogen sulphide, an evil smelling and poisonous gas.

Then came plans to turn waste products to profits—by separating the hydrogen sulphide, converting it to sulphur and selling the purified gas.

The prime contract for engineering and constructing these facilities, embracing a gas purification plant, sulphur recovery plant, water softening plant, sulphur storage and loading equipment, and buildings, was handled by The Girdler Corp.

Thus Girdler's wide experience in gas processing is once again paying dividends—in the country's largest plant of its type. Elemental sulphur, vital to the mobilization effort, is produced at the rate of 300 tons a day. And the flexibility of the plant permits coordination of sulphur, gas, and oil production at the optimum over-all rate.

If efficient gas processing is necessary in your operations, put our experience to work for you, too. The Girdler Corp., Gas Processes Division, Louisville 1, Kentucky.

Write for bulletin describing our services. The Girdler Corporation designs and builds plants for the production, purification or utilization of chemical process gases; the purification of liquid or gaseous hydrocarbons; the manufacture of organic compounds.

THE GIRDLER CORPORATION
Gas Processes Division

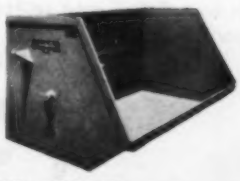
How The Dempster-Dumpster System Cuts Cost of Equipment . . . Eliminates Re-Handling of Materials!

One Truck-Mounted Dempster-Dumpster Picks Up, Hauls and Dumps Scores of Pre-Loaded Containers, One After Another, Regardless of Size or Design for Handling Liquid, Solid, Trash, Dust, Light, Heavy or Bulky Materials.

You can eliminate large investments in trucks, reduce the cost of gas, oil and maintenance . . . avoid time lost by loading crews while trucks make haul . . . and eliminate re-handling of materials by installing the Dempster-Dumpster System!

In the first place, three to five conventional dump trucks with crews cannot possibly do as efficient and economical a job as one truck-mounted Dempster-Dumpster with only one man, the driver. Dempster-Dumpster Containers are spotted at convenient accumulation points inside and outside your plant. The driver and his Dempster-Dumpster are constantly on the move servicing one loaded container after another. The Model LFW Dempster-Dumpster illustrated above handles containers up to 12 cu. yd. capacity. Containers up to 21 cu. yds are available for use with our Type ARLF and Type DTLF Dempster-Dumpsters. Your Dempster-Dumpster and driver may be handling liquids on one haul, solids on another, waste materials on another, etc. The Dempster-Dumpster driver can pick up a load, put it in carrying position and dump it in 2¼ minutes!

Without question, the Dempster-Dumpster System is the most economical and most efficient method of plant materials handling by truck yet devised! Write today for complete information. Manufactured exclusively by Dempster Brothers, Inc.



DEMPSTER BROTHERS, 5111 Dempster Bldg., Knoxville 17, Tennessee

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Canada's First and Canada's Largest Cat Crackers... for Imperial

Imperial Oil Limited placed its first order for process equipment with Kellogg back in 1938. This initial order was for a combination topping and thermal cracking unit. In succeeding years, Kellogg-engineered delayed coking, thermal reforming and alkylation units followed.

In 1948 Imperial put Canada's first Fluid catalytic cracker on stream at Montreal...a unit engineered and constructed by Kellogg. In June of this year, another Fluid unit was completed by Canadian Kellogg at Imperial's Winnipeg refinery.

Today, Canada's largest catalytic cracking unit—a 25,000 BPD Fluid unit—is going up at Sarnia, Ontario. Canadian Kellogg is engineering and constructing this cracker as well as a new two-stage distillation unit with a capacity of 50,000 BPD... also Canada's largest.

THE M. W. KELLOGG COMPANY

A SUBSIDIARY OF PULLMAN INCORPORATED

for fifty years an integral part of processing history

NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

KELLOGG 1901-1951 50th Anniversary

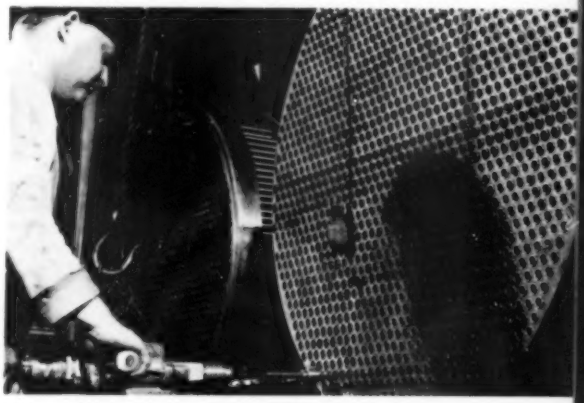
Portrait at

This year is Kellogg's fiftieth of service to industry. At this time naturally, as a group of men—known collectively to the modern business world as The M. W. Kellogg Company—we can think back nostalgically. We can remember the chimney stacks

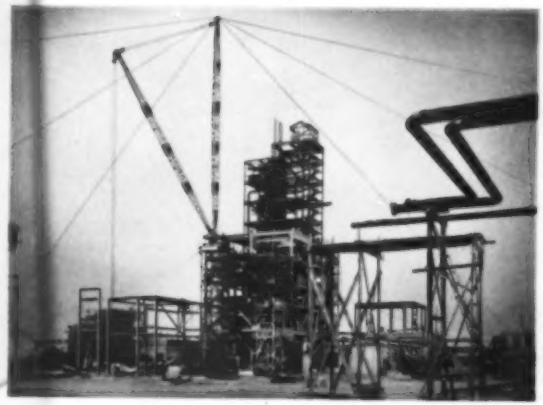
"Construction's battle with time!"

In previous issues of this magazine, "camera portraits" of M. W. Kellogg today have highlighted major aspects of Kellogg's research, development, engineering, procurement and fabricating activities.

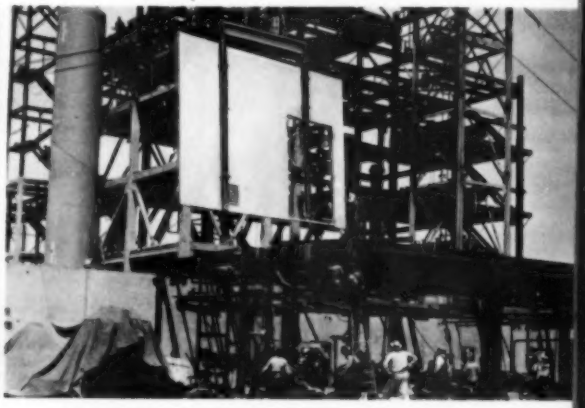
This month, the camera picks up the tour on the floor of the Heat Exchanger Shops in Jersey City. From there it swings to the construction lot, focussing on some of the techniques Kellogg utilizes in its continuing "battle with time."



1. ***HEAT EXCHANGER FABRICATION***, in essence a combination of piping and vessel fabrication, is another major activity in the shops. Here in the assembly section of the Exchanger Shops, the most modern type of electronic-control roll-in equipment is used. Kellogg heat exchangers in service run the gamut of size . . . from 6-inch outside diameters to 13 foot diameter shells containing 8,000 tubes.



4. ***NOW TAKEN-FOR-GRANTED*** in major plant construction, the towering guy derrick was first introduced in the field by Kellogg construction engineers. The cumulative industry-wide savings—both in time and money—resulting from this one construction innovation are illustrative of the results achieved by constant efforts to improve methods and equipment.



5. ***PERMANENCY OF THE KEY STAFF*** which plans and directs construction activities . . . and close day-to-day integration with the design engineering staff are responsible for the company's improved methods in the field. The adoption of the "pre-fab" assembly line on the refinery site (that's a whole pre-fab wall in the air) is one of the unusual techniques pioneered by Kellogg construction crews.

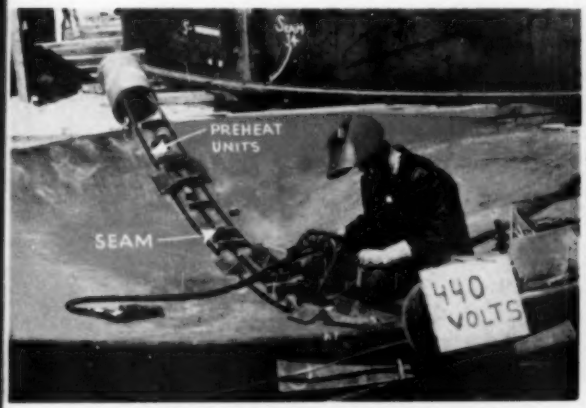
Fifty... not 10

M KELLOGG W
1901-1951
50th Anniversary

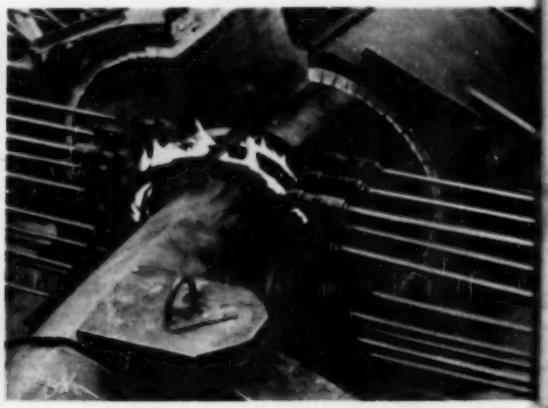
we built in 1901 . . . the first crude vessels for oil refiners in the 'teens . . . our first combination unit . . . the forty-odd Fluid cat crackers built in these years. But, after all, The M. W. Kellogg Company is only a factor as it is able to serve industry today. For that reason, we are presenting this series of monthly camera studies which document our belief that a truly integrated organization can better serve industry to achieve greater earning power. This is No.10 in the series.

2. *TYPICAL OF THE ASSORTMENT* of exchangers that might be found on the Shop floor on any given day . . . these units represent applications varying from pressures of 5,000 pounds per square inch at temperatures of 1100°F. to high vacuum service at below freezing temperatures of the order of liquid oxygen. Final destination . . . a job site.

3. *ON THE JOB SITE* the same principles employed in engineering and fabrication—detailed planning, efficient tools (created if necessary), constantly modernized techniques, experienced supervision—all pay off in reduced costs and shortened construction periods. The company's permanent construction staff is large . . . can handle as many as forty major construction projects at one time.



6. *ANOTHER RESULT* of close integration in the Kellogg organization is that the precise quality methods used in plant practice are quickly adopted for field use. This is true particularly of welding practices—such as induction pre-heating shown here—which are continually improved as more and more is learned about the behavior of metals.

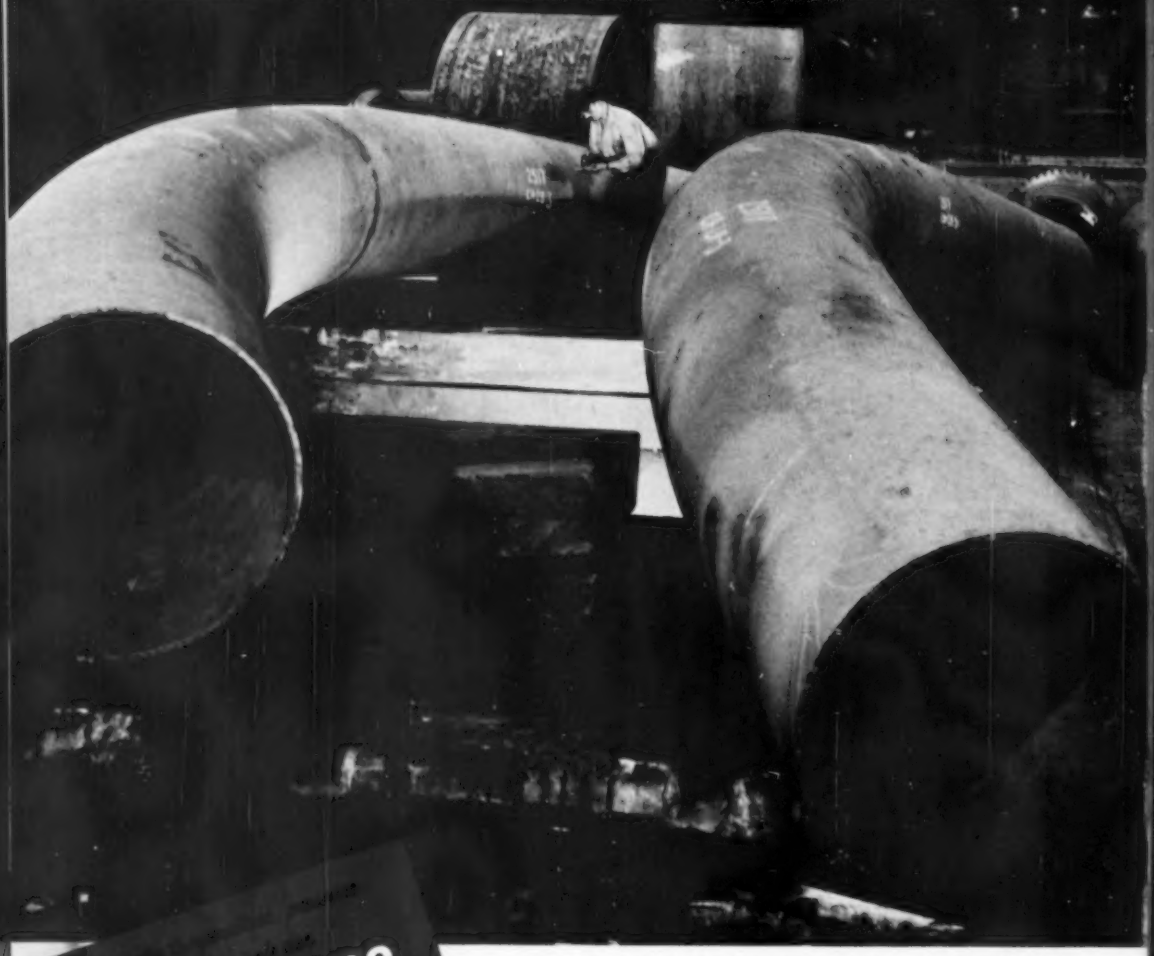


7. *IN SOME INSTANCES* in field construction, it pays to do most of the pipe bending in the field, and Kellogg's job site, pipe bending set-ups are virtual miniatures of the company's extensive shop operation—from equipment to methods. Piping up to 36 inch diameter has been successfully and economically bent in the field.

NEXT MONTH

. . . in the eleventh and final edition of this series of "camera studies" of M. W. Kellogg today . . . the camera finishes its tour of the construction lot and focusses on the overall picture of Kellogg's service to industry.

Bent to beat stress corrosion!



M. W. KELLOGG

In high temperature operation, stress corrosion has been found to be particularly aggravated adjacent to latitudinal weld seams in segmented pipe bends. Kellogg's exclusive method of incrementally bending pipe up to 96" in diameter provides bends that have no latitudinal welds in the arc . . . that present an even contour throughout their length.

Special Studies of unusual problems such as stress corrosion and graphitization to assure long life and low maintenance.

Exclusive Equipment for accurately analyzing stresses in piping and providing unique data for critical installations.

Top Welding Performance in shops and in the field by welders accustomed to working under X-ray checks.

Metallurgical Research by recognized specialists who have made major contributions in this field.

Complete Facilities for the fabrication of steel products from simple forgings to specially cast bimetallic devices.

Rigid Quality Control, devised by specialists, including chemical and micro analyses as well as mechanical and non-destructive testing.

Pressure Vessels
Vacuum Vessels
Fractionating Columns
Drums and Shells
Heat Exchangers
Process Piping
Pressure—Hi-temp
Power Piping
Ends and Headers
Flat One-Piece Bends
Forged and
Welded Fittings
Radial Brick Chimneys

NEWS FOR OPERATORS IN WESTERN CANADA!

Canadian Kellogg Company has established complete shop facilities for the fabrication of all types of piping at EDMONTON in Alberta Province. Inquire directly or through any Kellogg office.

The M. W. Kellogg Company *(A Subsidiary of Pullman Incorporated)* **New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, Paris**

Why Phosphorized Admiralty Condenser Tubes?

They Resist Corrosion by Most Natural Waters

Whether you use fresh, salt or brackish circulating water, service records testify that Admiralty metal tubes have given very satisfactory performance in refinery service heat exchangers.

Such corrodents as carbon dioxide, hydrogen sulfide, chlorine and metal salts, in the concentrations normally found in natural waters, or used in their treatment, as well as many of the contaminants in crude petroleum, are effectively resisted by tubes made of Admiralty.

Adding as little as 0.02% *Phosphorus* to Admiralty gives maximum resistance to dezincification while retaining all the other desirable properties of this alloy.

In order to assure *uniform* chemical composition and *soundness*, Scovill produces its Phosphorized Admiralty tubes by the continuous billet-casting process which continuously maintains the optimum amount of phosphorus. The tubes are hot-extruded from the continuous-cast billets, then are cold-drawn, annealed, cleaned and finished to produce tubes of uniform temper, gauge, straightness, roundness, diameters, length and freedom from burrs.

A Condenser Tube Booklet is available to qualified users who request it on their business letterhead. Scovill Manufacturing Company, 14 Mill Street, Waterbury 20, Connecticut.

Only Scovill Phosphorized Admiralty Has All These Advantages . . .

- Uniformity and soundness resulting from Scovill continuous-casting techniques
- Relative immunity to dezincification
- High resistance to sulfides and other active sulphur compounds
- Superior performance in fresh, salt, or brackish waters
- Satisfactory resistance to weak mineral acids and acid mine waters
- Good resistance to velocities under 7 fps.
- Excellent performance at relatively high operating temperatures

SCOVILL

A PRODUCT OF SCOVILL

8-1-3

SCOVILL CONDENSER TUBES

"You can't buy better brass"

Here's just one of the many efficient, economical Eagle-Picher Insulations. It's Eagle-Picher one-coat, all-purpose cement—a revolutionary new product that combines insulating and finishing materials ...that goes on in one easy-to-apply coat.

It gives your equipment highest possible thermal efficiency . . . cuts operating costs by saving fuel . . . and helps to provide perfect, precise control on temperatures.

Whatever your requirements . . . there's an Eagle-Picher Insulation that can fit your needs. Find out about them right away!

THESE EAGLE-PICHER PRODUCTS CAN SAVE YOU MONEY . . . POWER . . . TIME

Insulating Felts • Supertemp Blocks • Blankets Loose Wool • Pipe Covering • Stalastic Insulseal • Insulstic • Swetchek • Finishing Cements • Insulating Cements • Fireproofing Cement • Diatomaceous Earth Blocks

EAGLE-PICHER ONE-COAT, ALL-PURPOSE CEMENT!

A combination insulation and finishing material for temperatures to 1000 F. It's quick setting, rust-inhibitive . . . has light color, smooth surface, negligible shrinkage. It has exceptional adhesive qualities on ferrous metals and insulation materials. And it's unaffected by rain or moisture after it sets!

EAGLE EP PICHER

THE EAGLE-PICHER COMPANY • *General Offices: Cincinnati (1), Ohio*

Insulation products of efficient mineral wool — for a full range of high and low temperatures. Technical data on request.

Since 1843.

2072

These efficient, versatile insulations "team up" to give perfect insulation for every major application

For a completely effective, low-cost insulation combination, you can't beat the teamwork of Eagle-Picher Mineral Wool Blankets, Supertemp Blocks, Diatomaceous Earth Blocks and Earth Fill, and Super "66" Cement. They work effectively to give your equipment highest possible thermal efficiency . . . cut operating costs by saving the maximum amount of fuel . . . and help to provide perfect, precise control over temperatures.

EAGLE-PICHER MINERAL WOOL BLANKETS

These blankets satisfy the need for a convenient method of quickly and efficiently insulating flat or curved surfaces on larger types of heated equipment. Mineral wool is felted and secured between flexible metal fabric. Outstanding physical and chemical stability enables Eagle-Picher Blankets to resist water, steam, corrosive fumes and normal vibration.

EAGLE-PICHER SUPERTEMP BLOCKS

Eagle-Picher Supertemp Blocks are lightweight (approximately 16 lbs. per cu. ft.). Can be cut easily with knife or saw to fit off-shaped areas . . . they fit snugly over minor irregularities. They're strong and have high refractory value. Withstand temperatures up to 1700 F. Conductivity at 512 F. approximately 0.53 . . . all standard sizes, from 2" x 18" to 12" x 36" in thicknesses from 1" to 4".

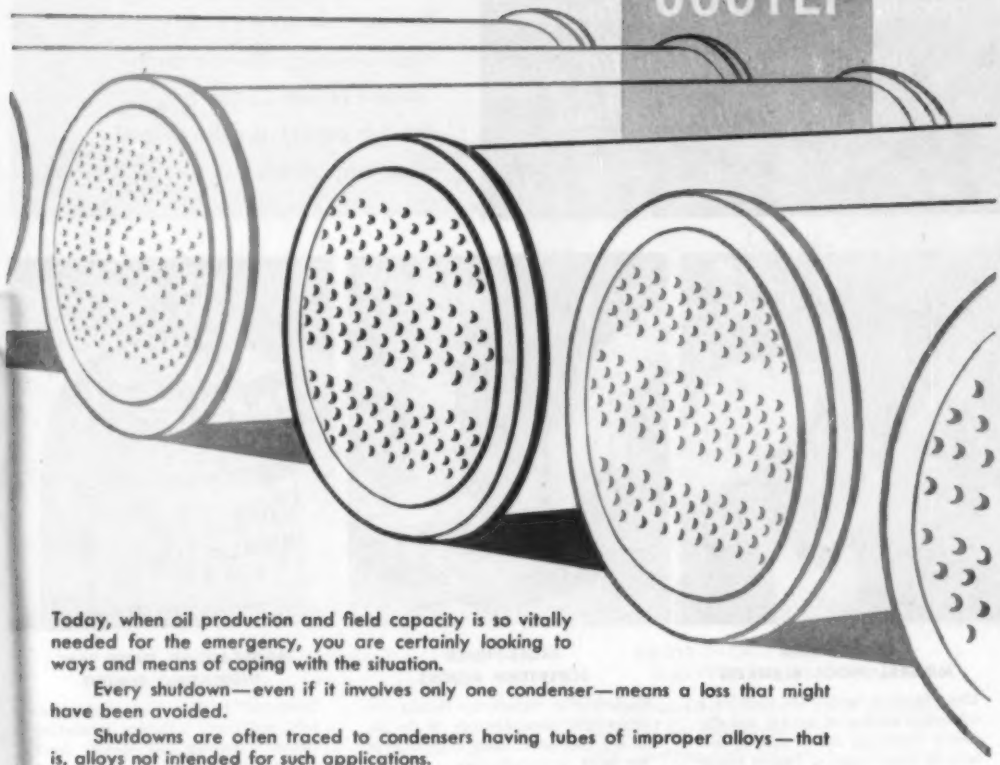
EAGLE-PICHER SUPER "66" INSULATING CEMENT

Super "66" is all-purpose, rust-inhibitive, extremely adhesive insulating cement. "Springy ball" pellets don't collapse after application . . . give great coverage, retain their thermal efficiency. 100 lbs. covers approximately 55 sq. ft. —1 inch thick. Easily applied with trowel, over flat and irregular surfaces. Efficient for temperatures up to 1800 F. Reclaimable when used on equipment whose temperatures do not exceed 1200 F.

Eagle-Picher, as a member of the Industrial Mineral Wool Institute, urges that you look for this label. It is a certification by the manufacturer that his mineral wool product conforms to Commercial Standard CS 117-49 as issued by National Bureau of Standards, U.S. Department of Commerce in cooperation with the Industrial Mineral Wool Institute, New York, N.Y.

Losing efficiency

every one condenser is COSTLY



Today, when oil production and field capacity is so vitally needed for the emergency, you are certainly looking to ways and means of coping with the situation.

Every shutdown—even if it involves only one condenser—means a loss that might have been avoided.

Shutdowns are often traced to condensers having tubes of improper alloys—that is, alloys not intended for such applications.

Wolverine can provide condenser tubes in a variety of alloys and can counsel with you as to the best one to use under your prevailing conditions.

Let us help you in the selection of proper alloys to do the most efficient job for you.

WOLVERINE TUBE DIVISION
Calumet & Hecla Consolidated Copper Company
INCORPORATED
Manufacturers of seamless, nonferrous tubing
1431 CENTRAL AVENUE • DETROIT 9, MICHIGAN

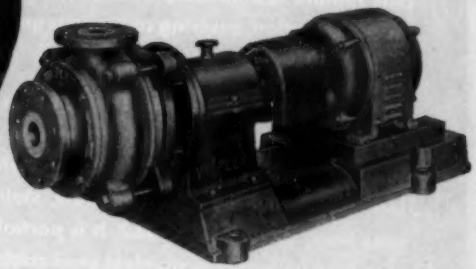
Wolverine Condenser Tubes stocked by Butler Industries, Inc., 355 South Fourth Street, Beaumont, Texas • Tel.: Beaumont 5-2351

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
Sales Offices in Principal Cities

Export Department, 13 E. 40th St., New York 16, N. Y.

brine solution

Buy **WILFLEY** *for*
Cost-Saving Performance



This WILFLEY Acid Pump is on brine service in a modern potash mill in the Southwest. It delivers continuous 24-hour-a-day service with NO DILUTION. A companion to the famous WILFLEY Sand Pump.

WILFLEY *Acid* PUMPS

D*ependable WILFLEY Acid Pumps* are setting new records for cost-saving efficiency in modern chemical plants all over the world. For corrosives, hot liquids, mild abrasives, electrolytics, antibiotics, pharmaceuticals, fertilizers and steel picklers, WILFLEYS have established and are maintaining leadership in the field. Available in 10- to 2,000-G.P.M. capacities; 15- to 150-ft. heads and higher. Wetted parts of practically all machinable alloys. Plastic lined models available. Individual engineering on every application. Write or wire for full details.

A. R. WILFLEY & SONS, INC., DENVER, COLORADO, U.S.A.
NEW YORK OFFICE: 1775 BROADWAY, NEW YORK CITY

The added PLUS

SHAND & JURS Automatic Tank Gauges not only provide maximum tank gauging accuracy, increase safety and cut gauging time . . . they also deliver an equally important PLUS! This plus feature is embodied in the superior QUALITY of their design and construction, assuring continuous gauging accuracy and longer, dependable operation.

Consider the S&J Automatic Tank Gauges on these Cone and Floating Roof tanks for instance. A precision graduated stainless steel tape, easily read through the eye-level window in the reading housing, is activated by a non-sinkable, stainless steel encased Foamglas float, pioneered by S&J. It is partially counter-balanced by a cast lead weight and stainless steel cable. The tape drum and pulleys are of thermo-setting phenolic and rotate on stainless steel roller bearings on stainless steel shafts.

These features are indicative of the quality built INTO S&J Automatic Tank Gauges ,so that you can get the maximum of dependability OUT of them.

Shand and Jurs Co. 8TH AND CARLTON STREETS : BERKELEY : CALIFORNIA

NEW YORK 295 Madison Ave. CHICAGO 10409 S. Western Ave. HOUSTON 837 M & M Bldg. TULSA 310 Thompson Bldg. LOS ANGELES 714 W. Olympic Blvd. SEATTLE 3000 Western Ave.

MONTREAL, QUE., 360 Notre Dame St. West VANCOUVER, B. C., 550 Beatty St. FORT ERIE, ONT. DARLINGTON, ENG. CARACAS, VEN

ALOYCO No. 1105 gate valve fully jacketed for heating valve

Lasts longer in corrosive service

If the application is on a line carrying corrosive liquids, a high alloy valve will save you time and trouble. ALOYCO specializes on high alloy valves with

A. metallurgical research devoted *exclusively* to corrosive applications;

B. foundry and machine shop facilities set up for high alloy valves *only;*

C. casting and machining practices dictated by the difficult characteristics of the alloys required for corrosive services.

Success Stories from ALOYCO'S Corrosion Clinic

THE CORROSIVE: Asphalt resin.

THE APPLICATION: Sampling high-temperature, high-viscosity asphalt resin in processing of lubricating oil.

THE PLACE: A large oil refinery.

THE PROBLEM: Standard cast iron gate valves, traced with a 150 psi steam coil, did not provide uniform heating, which gave trouble in sampling. They became loaded with asphalt, which caused them to stick. When finally opened, a solid slug of asphalt would come through.

THE SOLUTION: ALOYCO fully jacketed gate valves. Valve body and bonnet jackets are connected to 150 psi steam and valves are completely lagged.

Steam-jacketed ALOYCO valve insures free-flowing asphalt resin sample.

THE RESULTS: ALOYCO valves have been in service since 1948, and are used daily for sampling. Since valve is heated uniformly in body and bonnet, the asphalt flows freely and sticking is eliminated.

THE BACKGROUND: The ALOYCO Corrosion Clinic offers aid on all sorts of problems—not just corrosion. If the service is one that should be handled by a corrosion-resistant valve, the problem—whether it be corrosion, contamination, discoloration, temperature extremes or proper application—is one for the Clinic.

Among all valve manufacturers, ALOYCO is the *largest* specializing in high alloy valves. We make *more* corrosion-resistant valves than anybody else.

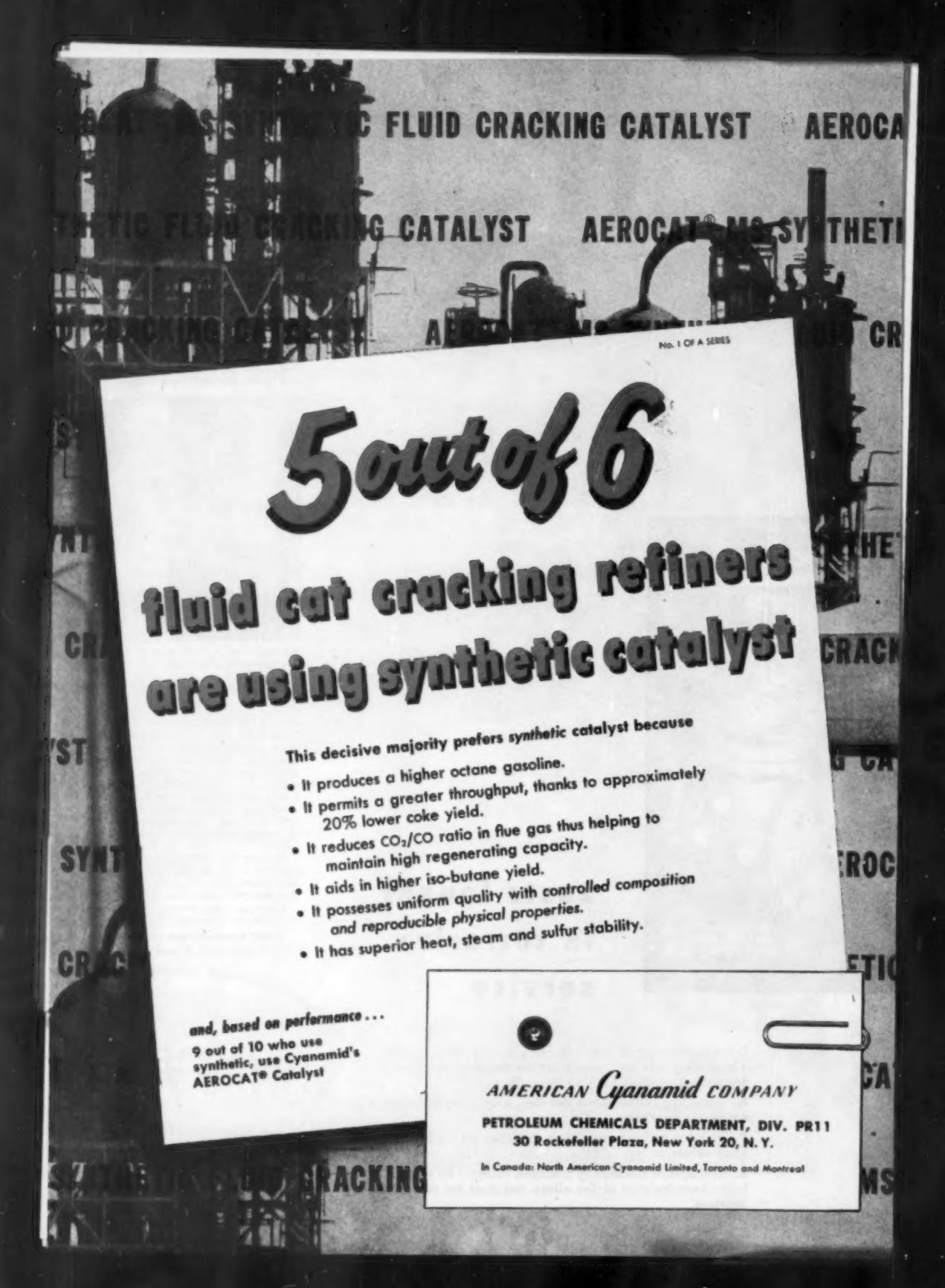
Cut valve costs. Put your problem up to ALOYCO'S Corrosion Clinic.

ALLOY STEEL PRODUCTS CO., INC.
1303 West Elizabeth Avenue, Linden, N. J.

Longer Lasting

ALOYCO VALVES

1st in Corrosive Service



No. 1 OF A SERIES

5 out of 6

fluid cat cracking refiners are using synthetic catalyst

This decisive majority prefers *synthetic* catalyst because

- It produces a higher octane gasoline.
- It permits a greater throughput, thanks to approximately 20% lower coke yield.
- It reduces CO_2/CO ratio in flue gas thus helping to maintain high regenerating capacity.
- It aids in higher iso-butane yield.
- It possesses uniform quality with controlled composition and reproducible physical properties.
- It has superior heat, steam and sulfur stability.

and, based on performance . . .

9 out of 10 who use synthetic, use Cyanamid's AEROCAT® Catalyst

AMERICAN Cyanamid COMPANY

PETROLEUM CHEMICALS DEPARTMENT, DIV. PR11
30 Rockefeller Plaza, New York 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

You don't have to baby this assembly

That's right! When you use the Bethlehem Continuous-Thread Stud, together with Bethlehem Quenched Nuts, you've got an assembly that will stand up in high-temperature, high-pressure bolting applications.

The Bethlehem Continuous-Thread Stud gives a good account of itself in difficult bolting jobs because it minimizes stress concentrations. The stud has no point of thread runout; consequently stresses can't concentrate at any one point. Instead they are distributed over the full working length of the stud.

And the Bethlehem Quenched Nut is economical because of its built-in strength. It is unlike common nuts because it is made from a 40 to 50 Carbon quality steel by forging and extruding hot metal into a forming die. This procedure, followed by quenching and tempering, arms the Quenched Nut with sufficient strength to break the stud or bolt on which it is used.

The Bethlehem Continuous-Thread Stud and Quenched Nut come in a wide range of sizes. Any way you look at it, they form an economical, long-lasting assembly that will do a good job for you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

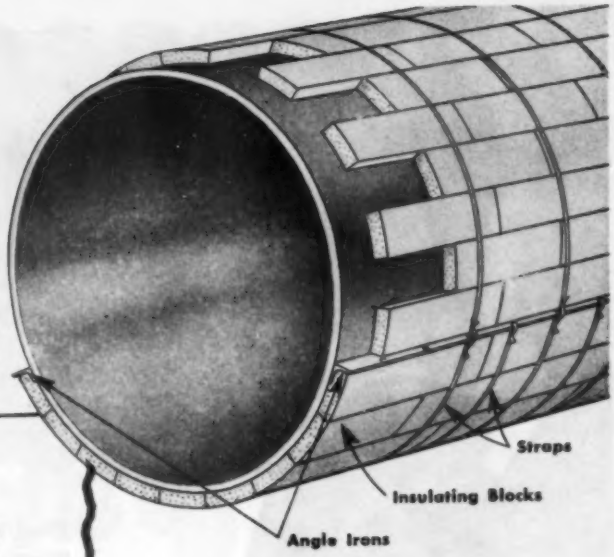
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Bethlehem supplies every type of Fastener

We have been asked . . .

"What's the best way to prevent insulation on the bottoms of large tanks from sagging?"



"We plan to insulate a large, cylindrical heated storage tank," writes a company power engineer. "We have had trouble with insulation sagging on the bottom of similar vessels. What method do you recommend for applying insulation so that we can avoid this trouble on the new installation?" Here is our reply:

While there are a number of ways for applying heat insulation to this type of equipment, many of them often prove unsatisfactory. The expansion and contraction of the heated vessel causes the wires, cables, or bands to expand. When this happens, the insulating material becomes loose, starts to sag, and pulls away from the bottom of the tank. One method of application—that of attaching blocks to wires and then holding them in place by cables directly around the metal tank surface—seems to allow more sagging than other methods. Even the use of bands on the outside of the blocks will not prevent sagging if expansion and contraction is appreciable and the vessel being insulated is large.

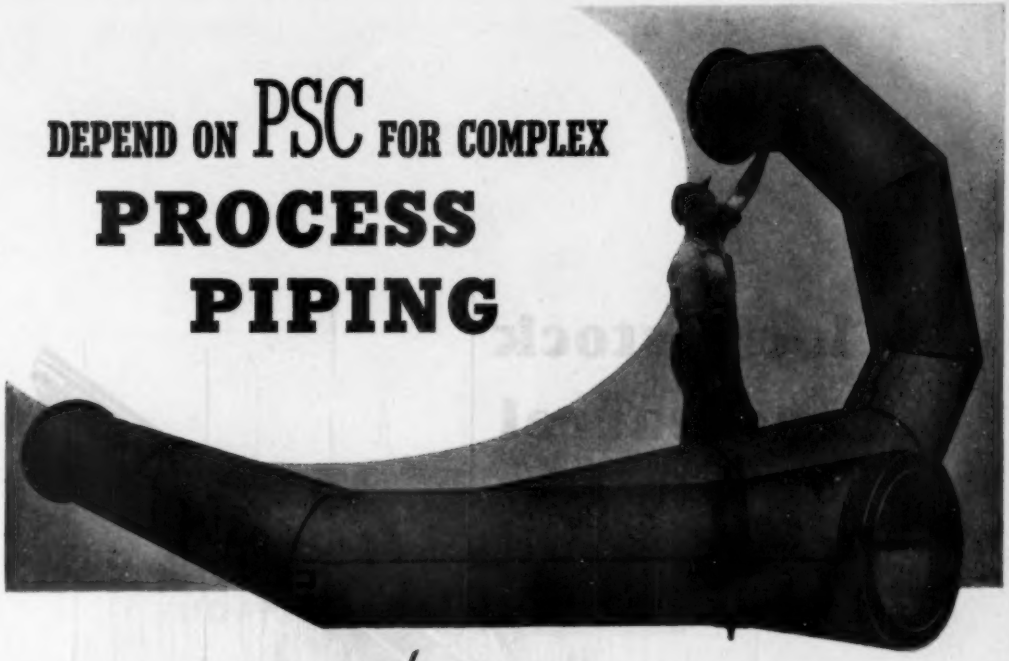
The best solution to this problem is illustrated above. Here, the insulation on the bottom third of the tank is held in place by bands which are firmly anchored to welded-on angle irons. These bands should be spaced about 6" apart to provide adequate support. The short distance from angle to angle greatly reduces the stretching that would occur if the bands completely encircled the tank. Helping you find the answer to any insulation problem is only a part of Armstrong's service.

We can take over the entire job for you—furnish top-quality materials plus skilled technicians to apply them—and eliminate the costly failures that often result from lack of knowledge or poor workmanship. Next time you're up against any kind of insulation problem, call your near-by Armstrong representative. Ask him about Armstrong's *complete* insulation service that insures you a thoroughly professional job.

SEND US YOUR QUESTIONS. If you have any questions on the use or application of either high- or low-temperature insulation, please do not hesitate to write us. We'll do our best to send you a prompt and practical answer. Just outline your problem on a post card or letter and address it to Armstrong Cork Company, 7511 Maple Street, Lancaster, Pennsylvania.

ARMSTRONG'S INDUSTRIAL INSULATIONS

DEPEND ON PSC FOR COMPLEX PROCESS PIPING



furnished in any SHAPE, DIAMETER or SECTION

As suppliers of welded alloy tubing to the petroleum and chemical processing industries for 25 years, The Pressed Steel Co. offers you a wealth of experience in the custom fabrication of tubing. Pictured at top is a typical example of the many complicated assemblies we are called upon to custom-fabricate. As pictured at right, we furnish tubing in any diameter up to 60", as well as in any wall thickness. PSC tubing of light gauges frequently effect large savings.

IN ANY ALLOY FOR YOUR SPECIFIC HEAT OR CORROSION PROBLEM

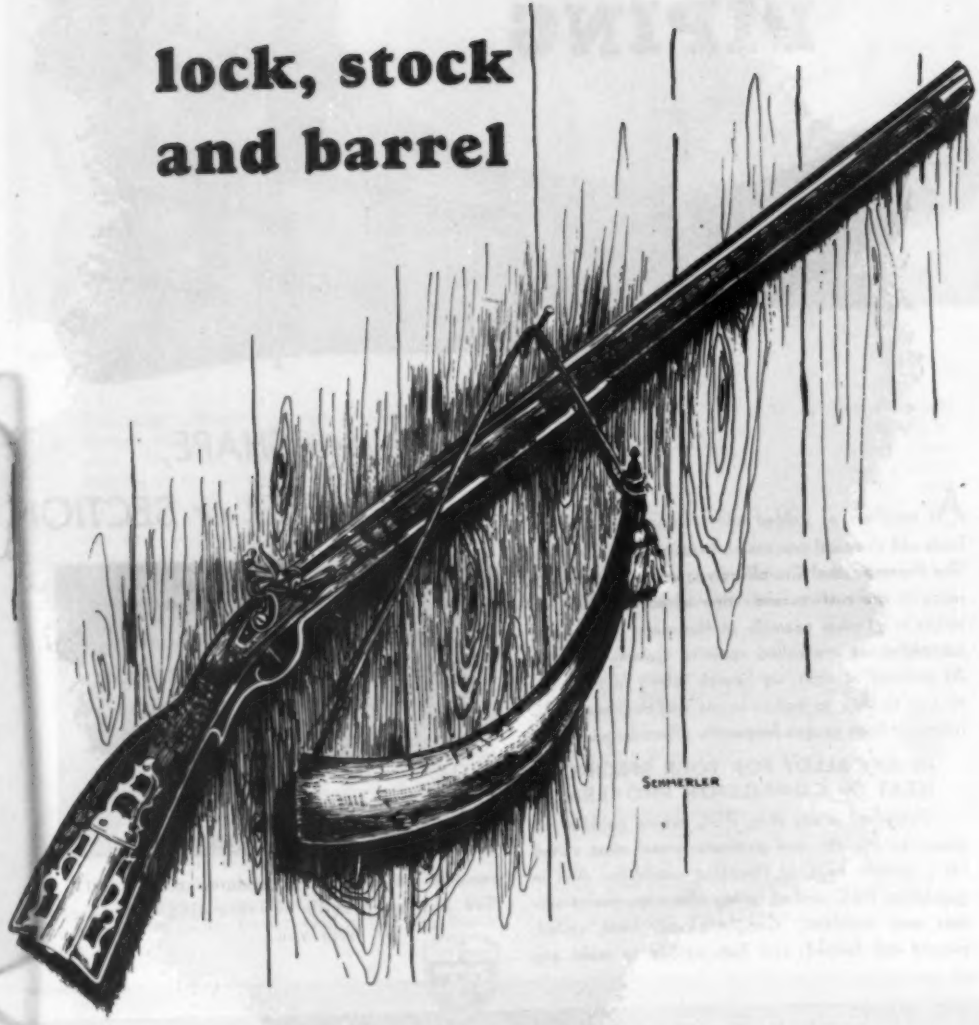
Furnished in any alloy, PSC tubing enables you always to use the one particular metal most suited for a specific heat or corrosion condition. And in quantities, PSC welded tubing offers impressive savings over seamless. Can be readily bent, coiled, swaged and formed; and butt-welded to make any required length. For temperatures up to 2200°F. See how our wealth of fabricating experience can help you.

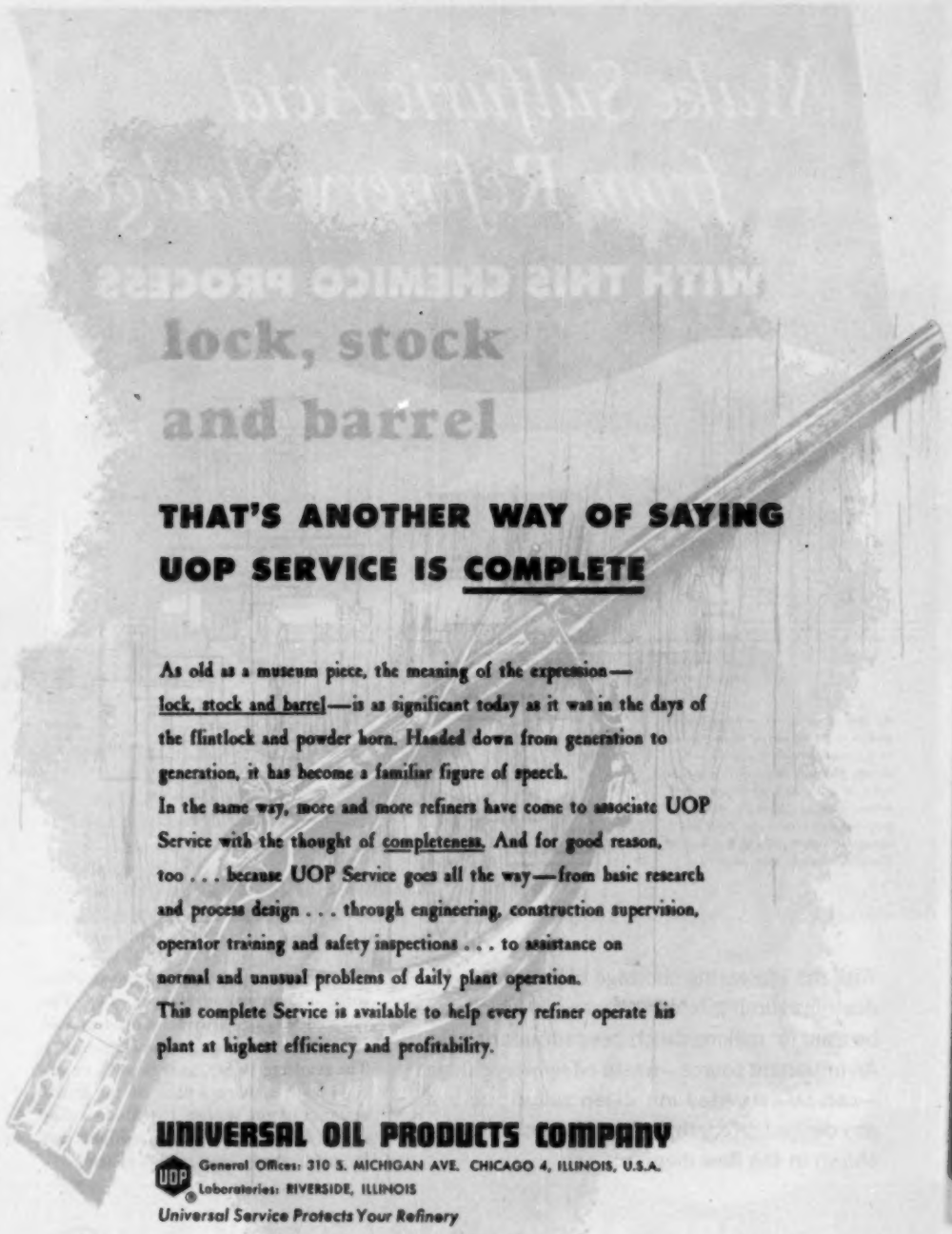
THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

lock, stock and barrel





lock, stock
and barrel

THAT'S ANOTHER WAY OF SAYING UOP SERVICE IS COMPLETE

As old as a museum piece, the meaning of the expression—lock, stock and barrel—is as significant today as it was in the days of the flintlock and powder horn. Handed down from generation to generation, it has become a familiar figure of speech.

In the same way, more and more refiners have come to associate UOP Service with the thought of completeness. And for good reason, too . . . because UOP Service goes all the way—from basic research and process design . . . through engineering, construction supervision, operator training and safety inspections . . . to assistance on normal and unusual problems of daily plant operation.

This complete Service is available to help every refiner operate his plant at highest efficiency and profitability.

UNIVERSAL OIL PRODUCTS COMPANY

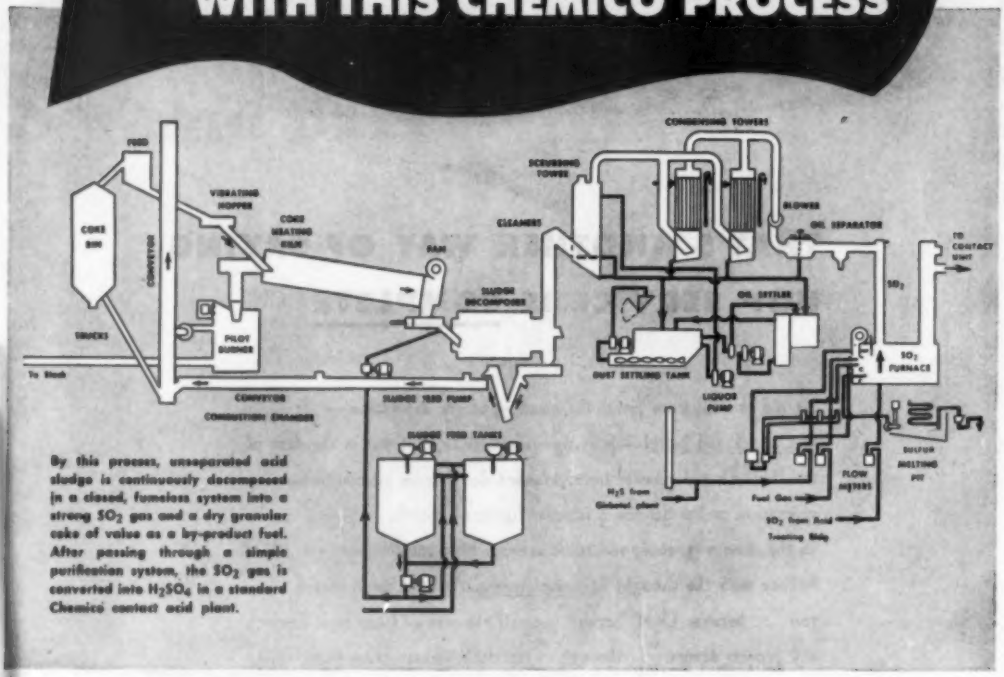
UOP

General Offices: 310 S. MICHIGAN AVE. CHICAGO 4, ILLINOIS, U.S.A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your Refinery

Make Sulfuric Acid from Refinery Sludge

WITH THIS CHEMICO PROCESS



By this process, unseparated acid sludge is continuously decomposed in a closed, fumeless system into a strong SO_2 gas and a dry granular coke of value as a by-product fuel. After passing through a simple purification system, the SO_2 gas is converted into H_2SO_4 in a standard Chemico contact acid plant.

With the increasing shortage of raw sulfur, industry is turning to other materials which can be used for making much-needed sulfuric acid. An important source—waste oil refinery sludge—can be converted into clean sulfuric acid of any desired strength by the Chemico process shown in the flow diagram.

This proved and practical process offers three important advantages. (1) The purified SO_2 gas provides a product acid that is free of carbon contamination. (2) The resulting H_2SO_4 may be 98% or any higher strength regardless of the initial strength of the sludge. (3) Sludges that cannot be processed by other methods may be satisfactorily used in this system.

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

488 MADISON AVENUE, NEW YORK 22, N. Y.

EUROPEAN TECHNICAL REPRESENTATIVE: CYANAMID PRODUCTS, LTD., LONDON W. C. 2, ENGLAND
CABLES: CHEMICONST, NEW YORK

CHEMICO

Chemico plants are profitable investments

for Your Share of that Extra 75,000 BBLS. PER DAY

● 94" diameter lathe gives the Posey Iron Works an edge on large jobs requiring lathework

Crude-oil input capacity of United States refineries is currently scheduled for an increase of 75,000 barrels per day. That means expansion of storage facilities to keep pace with production equipment now being installed.

For decades, Posey Iron has served the refinery industry with storage equipment especially designed to meet the requirements of the petroleum and L-P gas fields. Posey Iron engineering is based on a *practical* knowledge of the industry . . . the sort of "shirt-sleeves" knowledge that eliminates needless tardiness in delivery . . . needless increase in cost. Consult Posey about your storage requirements.

PRESSURE VESSELS FRACTIONATING TOWERS
ELEVATED TANKS STORAGE TANKS
LARGE DIAMETER FABRICATED PIPING
GENERAL STEEL PLATE CONSTRUCTION

● View shows bottom of recently erected 200,000 gallon Posey Iron Elevated Tank.

POSEY IRON WORKS, INC.

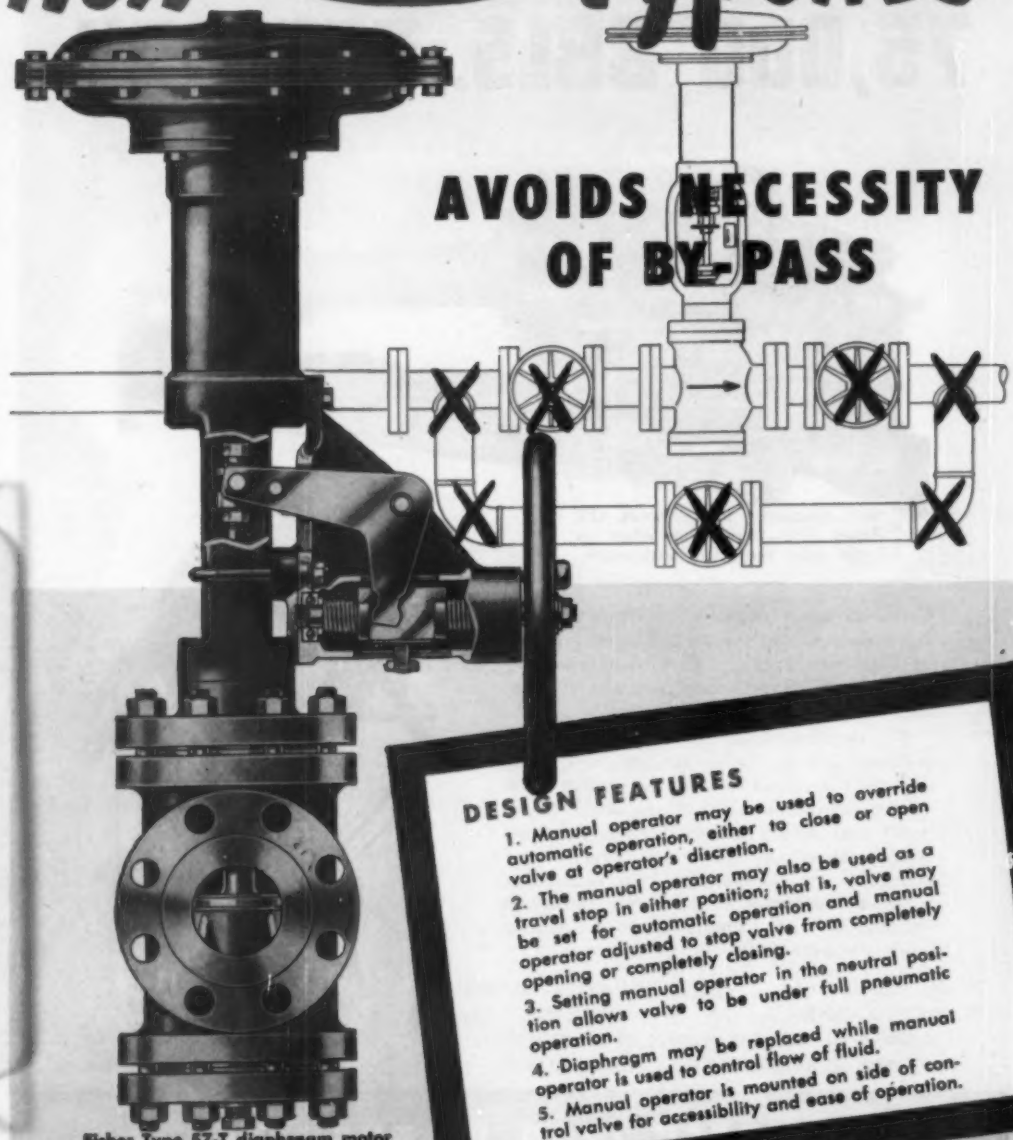
Steel Plate Division • Lancaster, Pa.

New York Office: Graybar Building

DIVISIONS: BRICK MACHINERY . . . INDUSTRIAL HEATING . . . IROQUOIS . . . SHIPBUILDING . . . STEEL PLATE

New FISHER Type MO

AVOIDS NECESSITY OF BY-PASS



DESIGN FEATURES

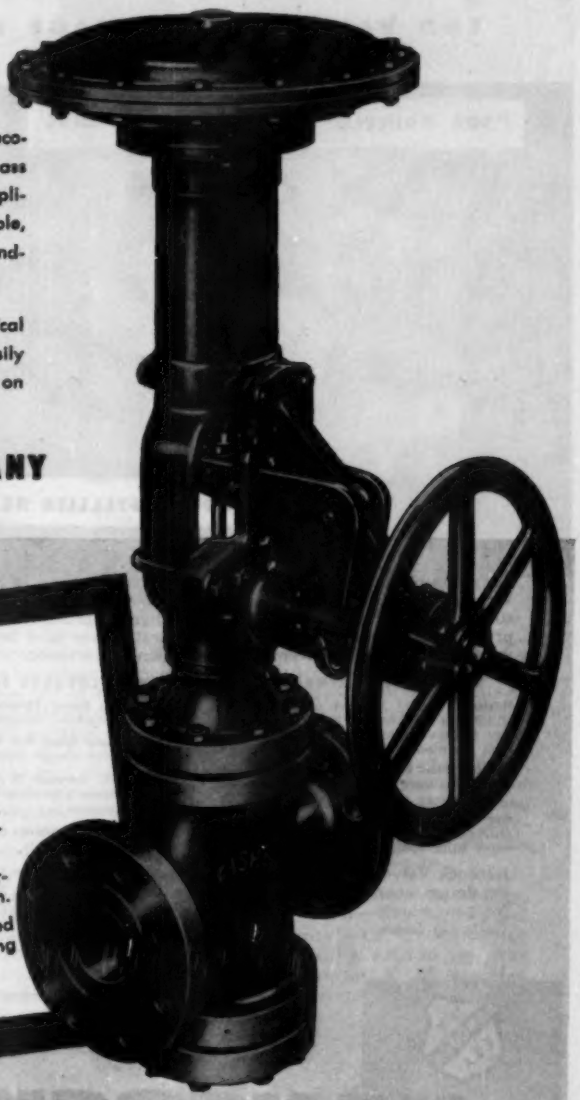
1. Manual operator may be used to override automatic operation, either to close or open valve at operator's discretion.
2. The manual operator may also be used as a travel stop in either position; that is, valve may be set for automatic operation and manual operator adjusted to stop valve from completely opening or completely closing.
3. Setting manual operator in the neutral position allows valve to be under full pneumatic operation.
4. Diaphragm may be replaced while manual operator is used to control flow of fluid.
5. Manual operator is mounted on side of control valve for accessibility and ease of operation.

Fisher Type 57-T diaphragm motor valve with side mounted Type MO handwheel operator in section.

FISHER

WORLD LEADER IN THE MANUFACTURE OF PRESSURE

Manual Operator



In some applications it may be desirable or economical to place responsibility of the by-pass function upon the control valve. For these applications, select the **Fisher Type MO.** It is a simple, rugged, economical, continuous connected handwheel operator that will handle this problem.

Construction places the handwheel in a vertical plane, making it more accessible and more easily handled than handwheel commonly mounted on top of diaphragm case.

FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA

CONSTRUCTION FEATURES

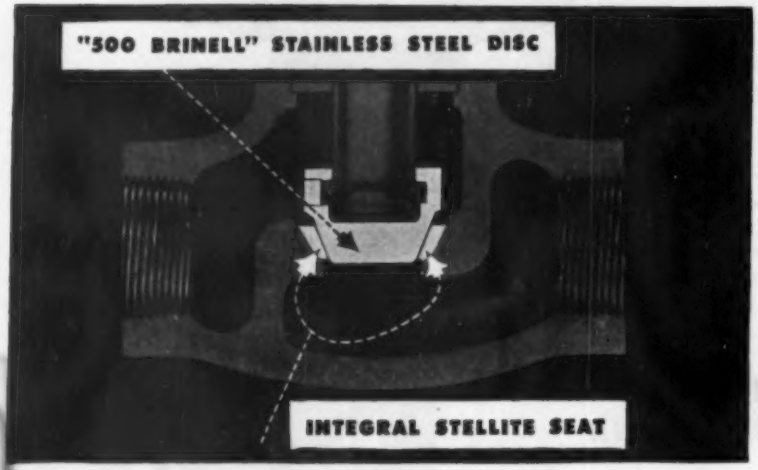
1. Handwheel fitted with spring loaded ball and socket recess to retain wheel in position when not in operation.
2. May be mounted on control valves in field that have tapped bosses on yoke. Requires only new diaphragm rod, adjusting screw and stem connector.
3. Grease packed radial and thrust bearings insure long life and easy operation.
4. Handjack operating screw constructed with pitch to give adequate operating power.

REGULATORS AND IN RESEARCH FOR BETTER PRESSURE CONTROL . . .

IN THERE . . . DELIVERING ALL THE TIME!

600# Hancock Steel Weldvalves

END VALVE SEAT LEAKAGE AND REPLACEMENT!



GLOBE TYPE

SIZES
¼" through 2"—Screwed and Socket Weld Ends.

SERVICE RATINGS

W.S.P.	600#	850°F.
O.W.G.	2000#	100°F.

Long, trouble-free service life—that's the record wherever Hancock Steel Weldvalves are installed. Integral stellite seat and "500 Brinell" stainless steel disc—accurately finished, perfectly aligned—provide permanent leak-proof tightness between body and seat. Seats never need be replaced. No wire drawing, galling, steam cutting, erosion, or corrosion.

CHECK THESE OTHER 600# HANCOCK WELDVALVE FEATURES:

Maximum Use of Welding adds strength, eliminates needless joints—the most common cause of leakage, gasket troubles and high maintenance costs.

Stainless Steel Ball Bearing Stem-to-Disc Connection for longer wear, even distribution of load, easy operation.

Corrosion-Resistant Back Seating permits stuffing box shut-off around the stem with valve fully open.

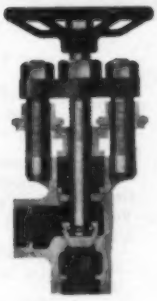
Extra-Strong Upper Structure—far stronger than conventional designs.

Yoke Post and Gland Nut Threads Protected permanently—always workable.

Streamlined, Compact Design saves space, permits close alignment of piping with near structures.

Special Treatment resists corrosion of valve exterior.

Hancock Valves cost no more than ordinary valves, despite their outstanding design, operating advantages and unlimited service life. So, get the best for your money—specify Hancock Valves. *When Hancocks Go In, Valve Costs Go Down.*



ANGLE TYPE

FOR PROMPT SERVICE, contact your nearby Hancock Valve Distributor.

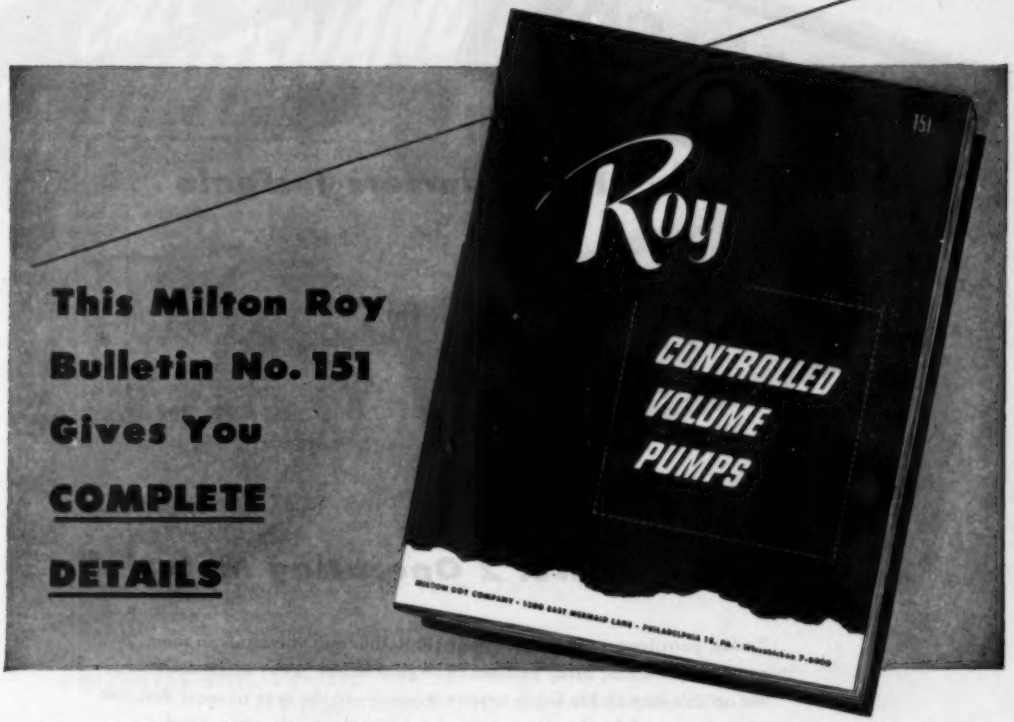
1877 HANCOCK U.S.A.

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** WATERTOWN 72, MASSACHUSETTS

MAKERS OF 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

CONTROLLED VOLUME PUMPING



Bulletin No. 151 is filled with information on controlled volume pumping. Here are a few of the many important details you'll find in the book:

- an explanation of controlled volume pumping.
- a description of what controlled volume pumping can do for you—what it does for others in the chemical, textile, petroleum, pulp and paper, paint, food and beverage, water treatment, pharmaceutical, and brewing industries and in instrumentation, pilot plants and laboratories.
- a description of how Milton Roy Controlled Volume Pumps give users maximum benefits; how any desired rate of delivery, from zero to full capacity, can be maintained with accuracy; how deliveries as low as 3 milliliters per hour can be held with precision; how difficult-to-pump materials, such as slurries, viscous liquids, solids in suspension, etc., are readily handled.
- 4 pages of color charts which show in dramatic "traffic-light" style the relative corrosion resistance of materials of construction to over 170 chemicals. These valuable reference charts summarize industry-wide data.
- a description of the features that make Milton Roy Controlled Volume Pumps perform flawlessly on services where no other pump has filled the need.

If your operations call for pumping a controlled volume of liquid in amounts as much as 50 gallons per *minute* or as little as 3 milliliters per *hour*, you'll find this book extremely valuable.

For your free copy of the 24-page, 2-color Milton Roy Bulletin No. 151, write or call the Milton Roy representative listed in your telephone directory. Or, if you prefer, write direct to us.

See Controlled Volume Pumps in action—visit our Booths 432 and 433 at the 23rd Exposition of Chemical Industries in New York.

WITH THE EXCLUSIVE STEP VALVE DESIGN

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MANUFACTURERS OF CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

Headquarters Insignia . . .

. . . for Refiner's No. 2 Operating Material

Today, petroleum refiners use about 1,000 different chemicals in their routine operations, many of them in large volumes. Away up in *number two slot* on this formidable list is *sorptive minerals*—to the tune of some 200,000 tons per year. Adsorbents, as vital processing chemicals, are second only to sulfuric acid.

It is all the more significant, then, that Attapulgus Fullers Earths and Porocel Activated Bauxites have become recognized standards in the field of adsorbents. As of now, at least a billion barrels of petroleum cuts—from the lightest distillates to the heaviest lube and wax fractions—have been treated by Attapulgus or Porocel materials to gain remarkable finished value.

This all adds up to a lot of specialized experience—intimate acquaintance with the process techniques for removing odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates from hydrocarbons, as well as for systems employing solid catalysts. And, of equal importance, laboratory and plant experience with the many treatments which precede the application of our two basic materials to specific adsorbent jobs.

Perhaps our broad knowledge can be of real help to you in selecting the right adsorbent and the right conditions. Our staff is at your service, without obligation.

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- **MASON-NEILAN** Reducing and Back Pressure Regulators—Liquid Level Controllers—all types for Oil, Gas, Steam or Water service.
- **CAST STEEL** Flanged End Gate Valves, Forged Steel Globe Valves, Gate and Check Valves.
- **SEAMLESS STEEL** Tube-Turn Welding Fittings, Ells, Tees, Caps and Reducers; Forged Steel Flanges—threaded, slip-on, welding neck, and blind—in sizes from ½" to 24" O.D.
- **HAGAN** Control Equipment, Hall Laboratories Water Conditioning.
- **NATIONAL** Seamless Steel Pressure Tubing, Seamless Steel Heat Exchanger and Condenser Tubes.
- **SMITH** Meters and SPARLING Meters, for your measuring problems in oil, gas, water, and other liquids.

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EQUIPMENT WITH ENGINEERING SERVICE

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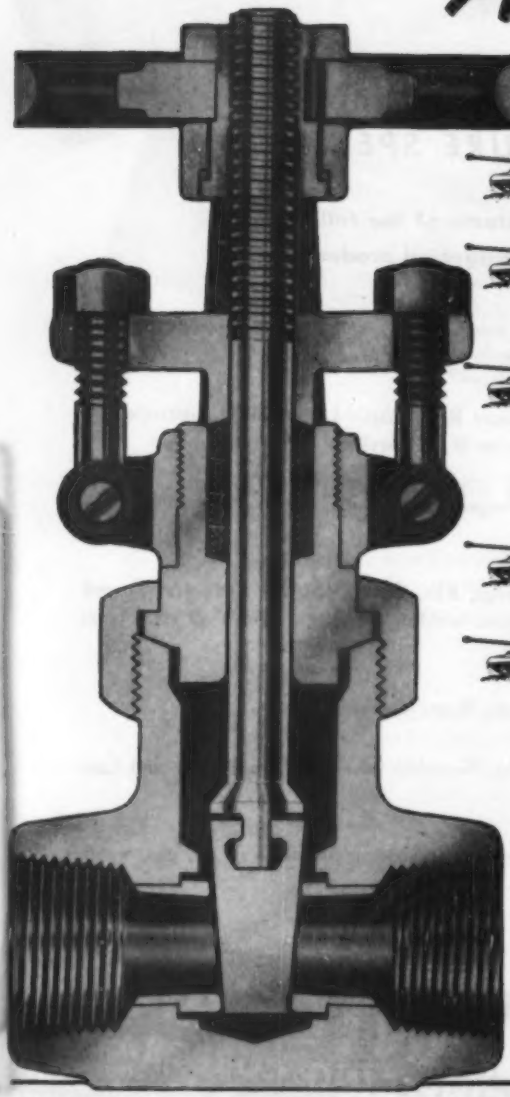
All 5 Vital Points are ARMORED



Body and Yoke are of Forged Steel, for extra strength and longer life.

Bolted Follower
with no follower threads on yoke to corrode. Follower easily tightened down any time when necessary.

Malcomized Gate Faces:
When furnished with either 12-14% or 18-8% stainless steel trim, List 960's gates are hardened by "Malcomizing," patented Chapman process. "Malcomizing" hardens to a minimum of 800 Brinnell, which minimizes seizing or galling and lengthens valve life.

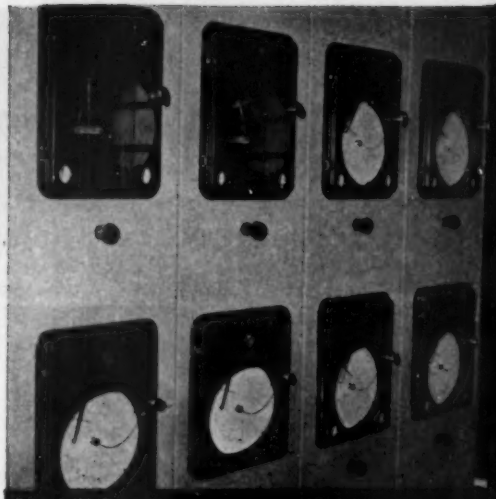
Super-Hardened Seat Rings
and wedge-faces of stainless steel help to save on repairs and replacements.

Strong Stem and Wedge Connection
Extra strength of stem-and-wedge gate connection provides protection against even unusual service stress.

Chapman List 960 is available in sizes from ¼" to 2" . . . in four different alloy-combinations of body and trim which qualify this rugged forged gate valve for many different services. Gasketed joint, or metal-to-metal. Rising stem with yoke (shown) or rising stem inside screw. Pressure range: 2000 lb. at 100°F.—380 lb. at 1000°F. (for higher pressures, specify List 990). Write for illustrated fact-sheet on List 960.

CHAPMAN'S LIST 960 FORGED Gate Valve

The Chapman Valve Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS



Serving The **OIL** and **GAS** Industries

More and more refinery and pipeline engineers are specifying American Meter Company's precision equipment for *accurate, automatic control* of flow, pressure, liquid level and other continuous process variables — with *minimum maintenance.*

These installations of the East Tennessee Pipe Line Company, for the control of natural gas, are typical in the gas industry — *Reliance CBVA Control Valves,* with valve positioners, are operated by *American Meter Company Pressure Controllers.*

For over a century, the American Meter Company has been serving industry — with a tradition of "Sustained Accuracy at Lower Cost."

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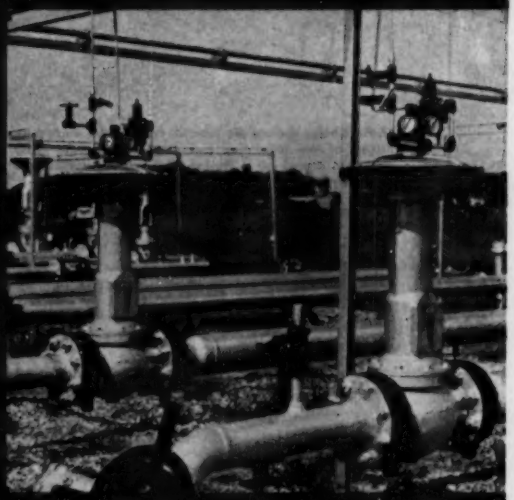
2. CBV Regulators, Pilot, Remote Controlled
3. Orifice Meters, Recording
4. Orifice Meters, Integrating
5. Orifice Meters, Telemetering
6. Orifice Meters, Integrating, Remote Counter
7. Meter Runs
8. Orifice Fittings
9. Differential Valves
10. Controllers, Pressure
11. Controllers, Flow
12. Temperature and Pressure Recorders



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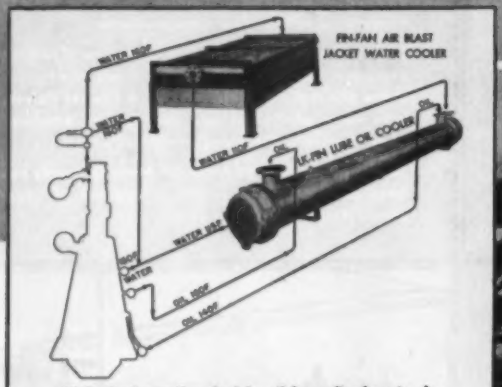
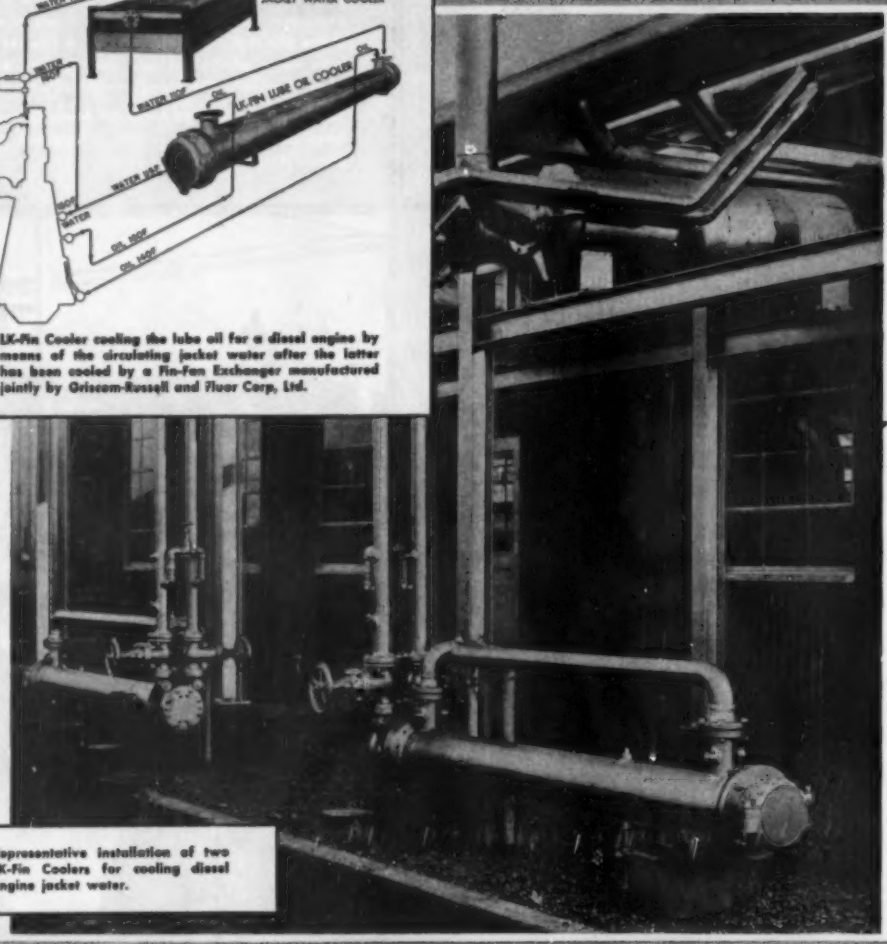
AMERICAN METER COMPANY

Why LK-FIN means a more



LK-Fin Cooler cooling the lube oil for a diesel engine by means of the circulating jacket water after the latter has been cooled by a Fin-Fan Exchanger manufactured jointly by Griscom-Russell and Fluor Corp, Ltd.



Representative installation of two LK-Fin Coolers for cooling diesel engine jacket water.

GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS

effective, compact, economical LUBE OIL OR JACKET WATER COOLER

It's because of the *fins* on the cooling elements. These fins greatly increase the external heat transfer surface . . . enable a considerably shorter tube to perform the same cooling effect that requires a much longer bare tube.

The results . . . a more compact cooler because of the more effective heat transfer surface . . . a more economical unit because of the shorter tubes and shell.

What diameter . . . thickness . . . pitch . . . should the fins be to accomplish these results? That's where G-R's unmatched know-how comes in . . . a knowledge gained from 20 years of experience in building *finned-type* heat exchangers and the results obtained from many tens of thousands of installed finned-tube units.

And the exclusive use of LK-Fin tubes is only one of the many distinctive features of these coolers. Write for bulletin describing them in detail, with rating tables and selection data.

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

GRISCOM-RUSSELL

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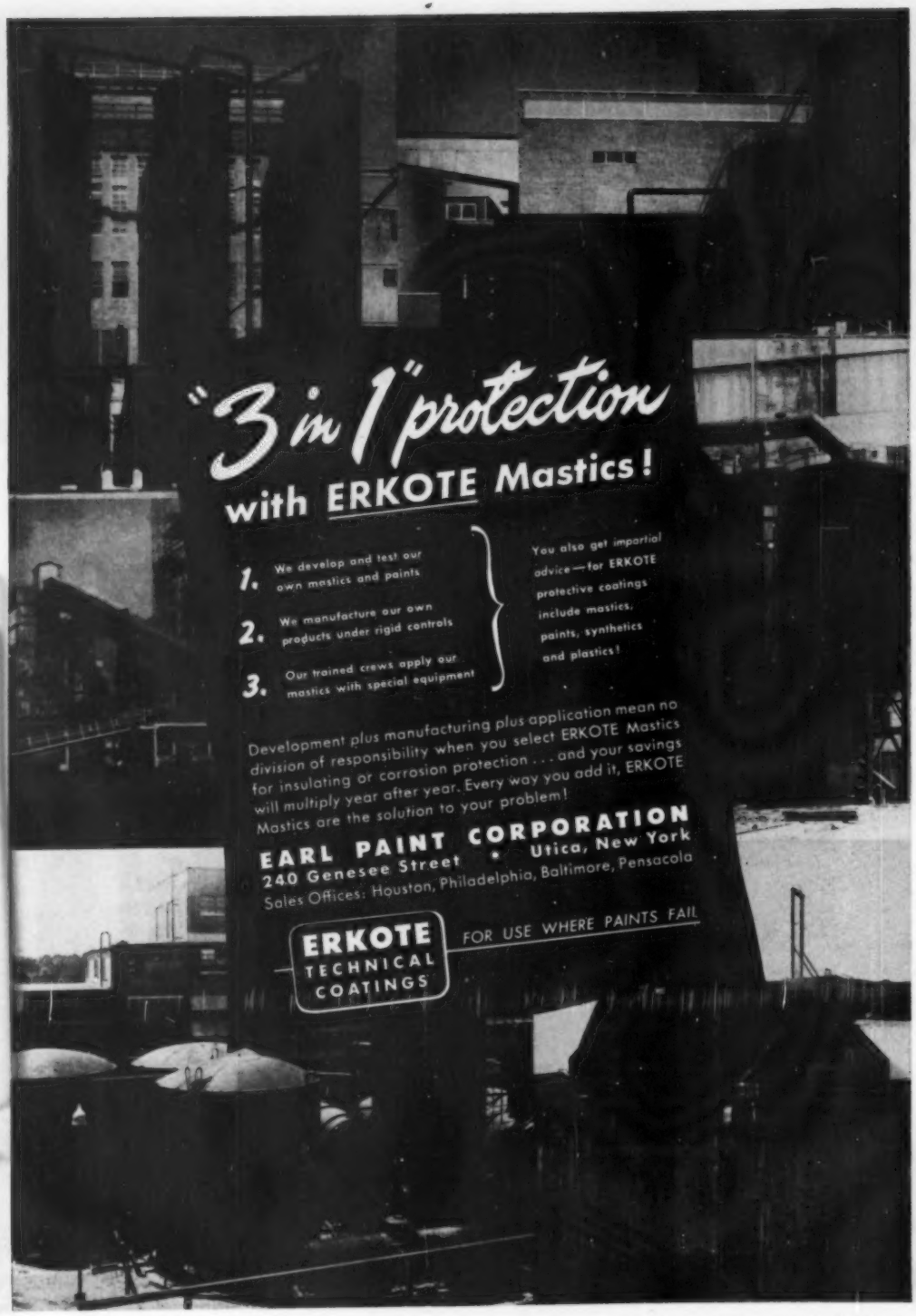
GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS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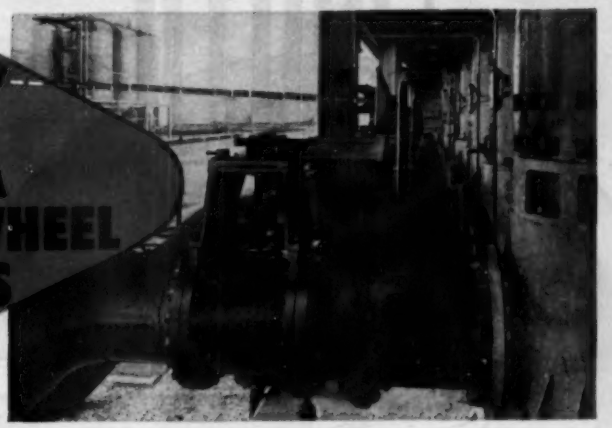
R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



SIX HANDWHEEL TURNS

. . . Operate these R-S Valves

This installation of twenty-inch valves in the water system to one of the large oil refineries in Louisiana is another example of R-S time-saving efficiency. Such ease of operation is an important consideration in any pumping operation and especially where a battery of synchronous driven pumps discharges into a common header. Burned-out motors at start-ups can be practically eliminated.

Substantial savings in pumping power result due to the low pressure drop. The beveled vane ordinarily seated at a 12½° angle means greater control rangeability either manual or automatic and no down-time for cleaning.

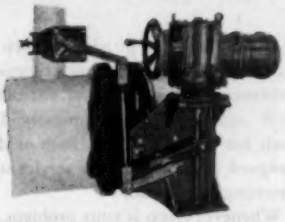
Install easily operated R-S Valves and obtain the most from your valve investment. Your local R-S representative is a valve expert—know him well.

R-S PRODUCTS CORPORATION

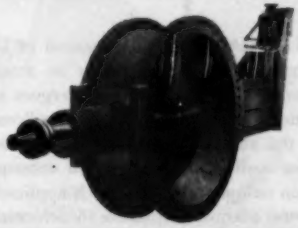
4600 Germantown Avenue, Philadelphia 44, Pa.

An S. Morgan Smith Company Subsidiary

REPRESENTATIVES IN PRINCIPAL CITIES



No. 798—Thirty-six inch and eight-inch R-S heavy duty valves of R-S "H" Metal at elevated temperatures for foundry cupola control. When the larger valve is wide open, the smaller valve is fully closed and vice versa. Slow operation is required, hence the motor operator with threaded reachrod.



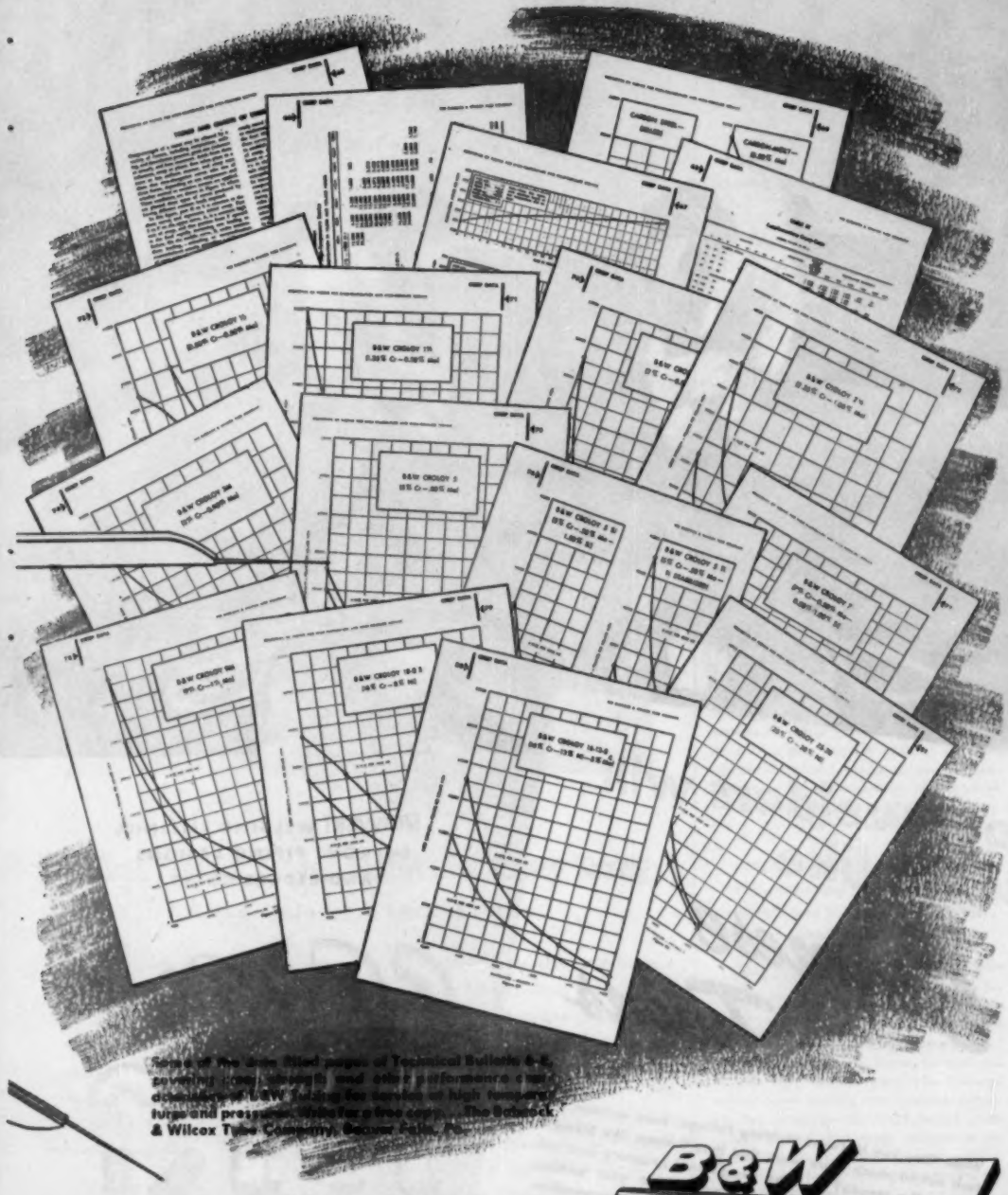
No. 735—72-inch 125-pound "H" Metal R-S Valve for elevated temperatures. Valve is equipped with dual cooling fins. Oil cylinder and positioner utilizes 200 psig oil and 0-15 psig instrument air. Positioner cam driven simulating straight line semi-log control curve.

let's take a CLOSER LOOK at CREEP STRENGTH

Steel Tubing subjected to long periods of high-temperature and stress conditions in chemical and petro-chemical equipment undergoes slow deformation, or plastic flow, known as "creep". To keep this elongation within safe limits so as to prevent costly tube failures and consequent production tie-ups, tubing for such applications must possess adequate resistance to deformation throughout its expected service life. Tubing made from molybdenum-bearing steels has found distinct favor for operating conditions requiring high creep strength ... because molybdenum is generally the most effective alloying element for increasing creep strength at a given cost.

As molybdenum provides resistance to creep at elevated temperatures, and chromium provides resistance to oxidation and corrosion—a complete series of chromium-molybdenum alloy steels has been developed. Each of these steels is designed to give optimum service under certain operating conditions.

Whenever creep is your problem, consult Mr. Tubes—your B&W Tube Representative. He offers you a wealth of experience and technical data in selecting tubing with optimum chemical and physical properties for operation at elevated temperatures and pressures ... from B&W's full range of carbon, alloy, and stainless analyses.



Some of the data filled pages of Technical Bulletin 6-E, covering creep strength and other performance characteristics of B&W Tubing for service at high temperatures and pressures. Write for free copy. The Babcock & Wilcox Tube Company, Beaver Falls, Pa.

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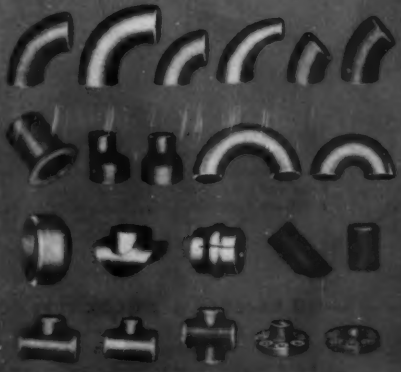
TA-14035

Your welders will seem like *Siamese Twins*

When they use Midwest Welding Fittings, your welders will turn out so much more work that they'll seem like Siamese Twins. The reason? . . . The exceptional accuracy and uniformity of Midwest Welding Fittings enable your welders to spend more time welding and less time in preparation.

MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGNS AND REDUCE COSTS



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This well-recognized reputation for top performance didn't just happen—more than thirty years' experience and development have gone into the manufacture of these outstanding gas welding supplies . . . know-how that produces high quality, reasonably-priced items that guarantee a job done faster, done better, done easier and done at less net cost.

For further information about Airco's oxyacetylene welding supplies which includes a complete line of rods, fluxes and brazing alloys, write your nearest Airco Office or Authorized Dealer for a free copy of Catalog 12.

More news about AIRCO products

AIRCO No. 1 ALLOY STEEL

A Smooth-Flowing, High Ductile Rod Insuring Good Control of Molten Pool

This rod (AWS Classification GA60) is ideal for welding low carbon and low alloy steels, including pipe of grades A and B analysis. Outstanding among its many important features is the high ductility in the "as welded" condition. Because of its mechanical properties, this rod is desirable when undertaking qualification tests like those included in The American Standards Association Code for Pressure Piping. It is smooth flowing, insuring good control of the molten pool, and, in addition, will withstand considerable heating without burning.

PHOS COPPER

A High Standard Copper And Phosphorous Brazing Alloy

It is self-fluxing when used on copper-to-copper joints but requires a good low melting point flux when brazing brass, bronze or other alloys. It is completely fluid at approximately 1382°F. at which temperature best results are secured and is used in the manufacture of electrical, refrigeration and air conditioning equipment. Available in rod and strip form.

AIRCO MARVEL BRAZING FLUX

A High Quality Flux That Remains Molten And Viscous Over A Wide Temperature Range

It is a uniformly high-quality flux for use in braze welding cast iron, malleable iron, copper and steel and for welding brass, bronze and copper. Marvel Flux remains molten and viscous over a wide temperature range. Its use protects the weld metal from oxidation and effectively reduces or removes oxides and other foreign matter. Marvel Flux is a general purpose flux for the welding shop.

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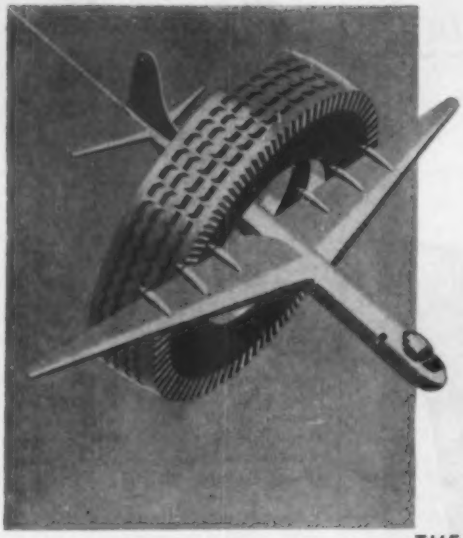

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TO MARK PROGRESS

...where flow efficiency is a vital factor

You can depend on Ladish Controlled Quality Fittings to maintain maximum flow characteristics of any piping system . . . and do it consistently year after year. For advanced Ladish engineering assures the true circularity, full effective radii and smooth inner surfaces necessary to keep turbulence and friction loss at a minimum . . . features which are doubly safeguarded by the high, inflexible standards of Ladish Controlled Quality.

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

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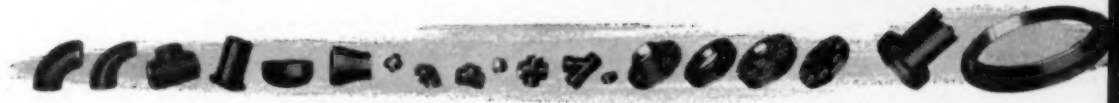


NOW 3 GREAT PIPE INSULATIONS

Amocel

joins Unibestos in the UNARCO line of asbestos pipe insulations

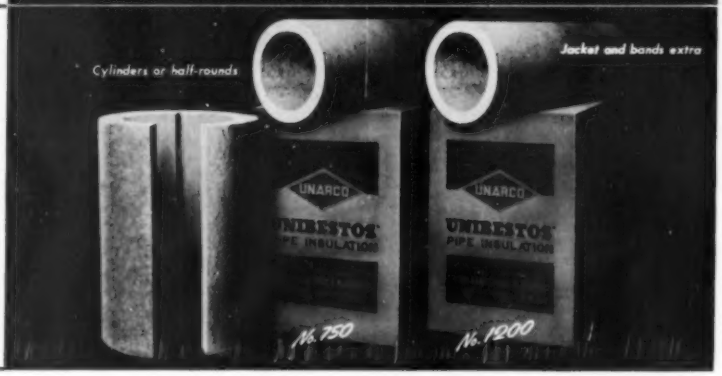
...up to 650°F.

Answering the demand for a jacketed pipe insulation for use in the lower heat ranges, UNARCO now offers Amocel — for temperatures up to 650°F. Like Unibestos, Amocel is made of Amosite asbestos fibers bonded with an inorganic binder. For pipe sizes from ½" through 12", in Standard thickness only. Light in weight. Highly efficient. Durable.

UNIBESTOS
...up to 750°F.

UNIBESTOS
...up to 1200°F.

2 GREAT PIPE INSULATIONS — Unibestos No. 750 and No. 1200 — long have been America's outstanding insulations in their respective temperature ranges. Regular production for pipe sizes from ½" through 24" in popular thicknesses through 4". Other thicknesses and sizes available on order.



We want you to have our Catalog — It gives you complete information on Amocel and Unibestos Pipe Insulations; Unibestos Insulating Block; Cements and Finishes; Flexible Insulations; Metal Mesh Blankets; Tailored-to-Fit Insulations; Asbestos Packings and Gaskets; Asbestos Textile Products . . . Just drop us a line today requesting that we send you UNARCO Catalog No. 76-109.

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Stop Tar Separation

in diesel and fuel oils . . . use

IONAD 17

Shell's fuel oil additive saves money four ways for refiners:

1. Ionad 17 eliminates filter screen clogging . . . the largest single cause of service troubles in domestic oil burner equipment. Burner parts are also kept free of tars and resins.

2. Ionad 17 makes fuel oil stocks more compatible.

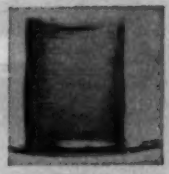
3. Ionad 17 minimizes treatment of fuel oil stocks. In many cases the cost of adding Ionad 17 is *more than paid for* by savings in reduced fuel oil treatment alone.

4. Ionad 17 prevents the accumulation of sludge on tank bottoms. As a result, tanks require less frequent cleaning.

Ionad 17 is a stable concentrate that is readily soluble in fuel oil stocks. It prevents the agglomeration of the tars and resins that form in most fuel oils from the polymerization of olefins. Its advantages are now available to refiners of fuel oils—get complete information from the nearest Shell Chemical office.

THE SAME FUEL OIL!

WITH IONAD 17



WITHOUT IONAD 17

Both filter screens operated for 28 days with No. 2 fuel oil.

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ENGINEERED DESIGN BY **HAMMEL-DAHL**

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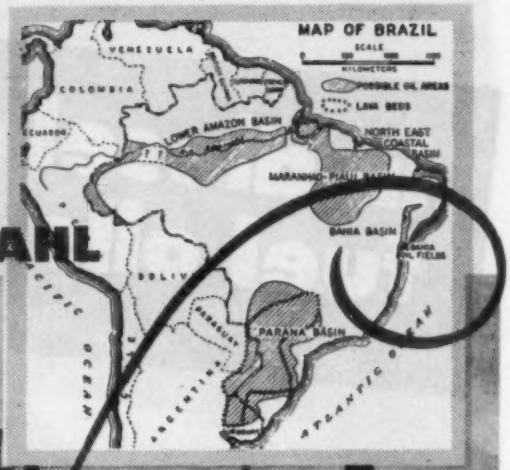

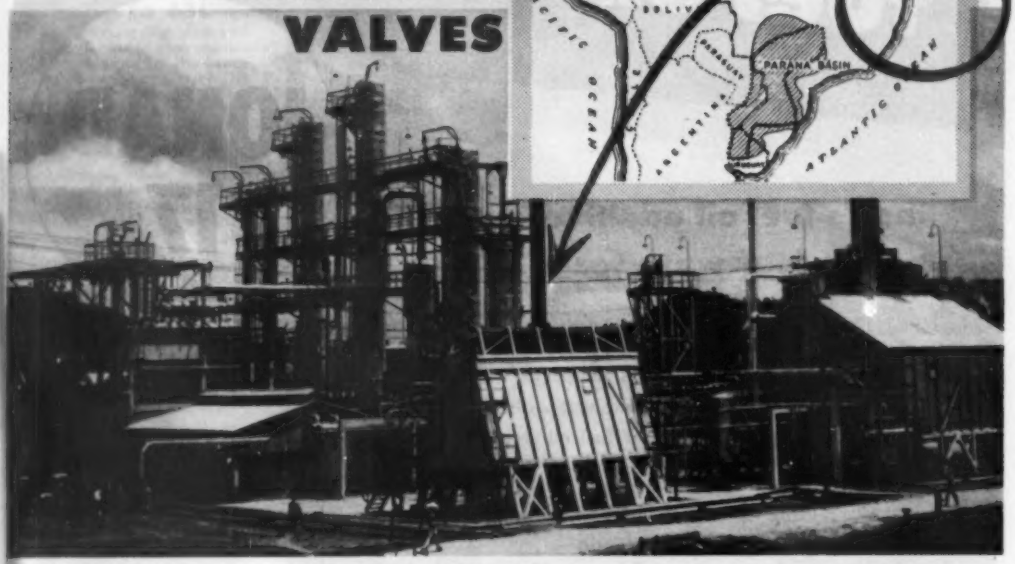

This new 2500 barrel per day Refinery — the first to produce cracked gasoline in Brazil — has recently been placed on stream at Bahia for Refinaria Nacional de Petroleo, S. A., by The M. W. Kellogg Company, refinery and chemical engineer-contractors of New York City.

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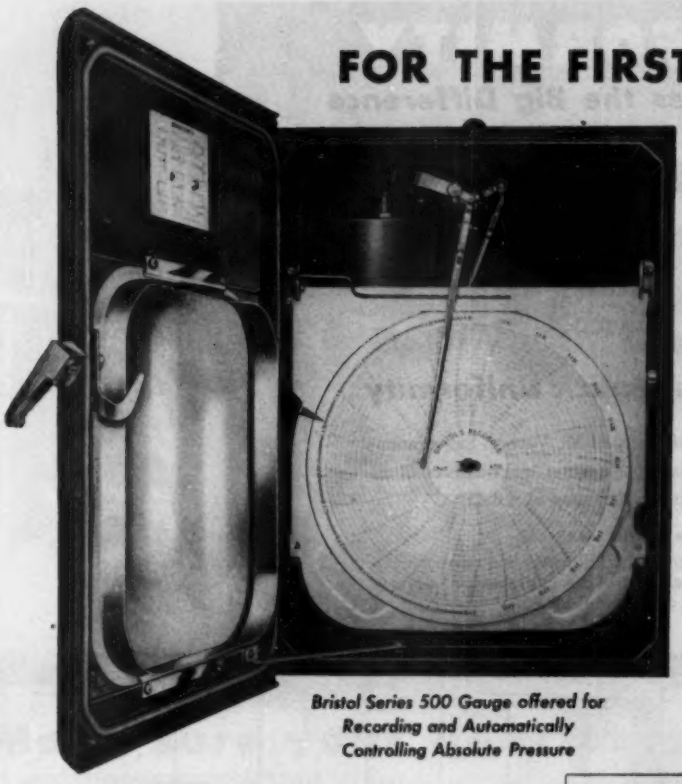
Accurate Mechanical Recording and Controlling of Absolute Pressure

IN RANGES AS LOW AS 0 TO 6 MM!



Bristol Series 500 Gauge offered for Recording and Automatically Controlling Absolute Pressure

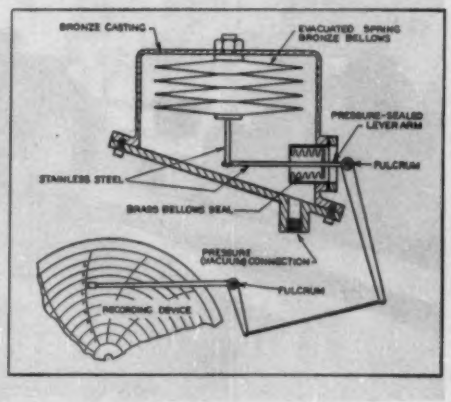
Again, Bristol scores a first!

Our new Low-Range Absolute Pressure Recording Gauge gives a direct reading of pressure above zero absolute, inherently corrected for barometric variations, with far greater accuracy than ever before possible—measuring ranges as low as 0 to 6 mm mercury absolute.

SINGLE BELLOWS—NO COMPENSATION NEEDED

Instead of *two* pressure elements—one for measured pressure, one to compensate for barometric pressure—Bristol uses a single calibrated bellows element, evacuated to practically a perfect vacuum, enclosed in a cast bronze pressure-tight housing. The bellows motion is transmitted outside the housing through an entirely new device—a pressure-sealed lever arm that is frictionless, entirely free from lost motion and turning moments due to changes in differential pressure across it.

Thus—with one measuring element, Bristol's Absolute Pressure Gauge operates in ranges hitherto considered impractical with metallic elements.



WHAT'S YOUR APPLICATION?

This entirely new, highly-accurate, direct-reading mechanical pressure instrument gives valuable information for controlling pressure wherever the operation of equipment depends upon a high and constant vaccum.

Bristol Low-Range Absolute Pressure Gauge is offered for recording, pneumatic or electric controlling, and pneumatic or electric remote transmission. For Bulletin G620, write THE BRISTOL COMPANY, 111 Bristol Road, Waterbury 91, Conn. (The Bristol Co. of Canada, Ltd., Toronto, Ont.; Bristol's Instruments Co., Ltd., Lynch Lane, Weymouth, Dorset, England.)

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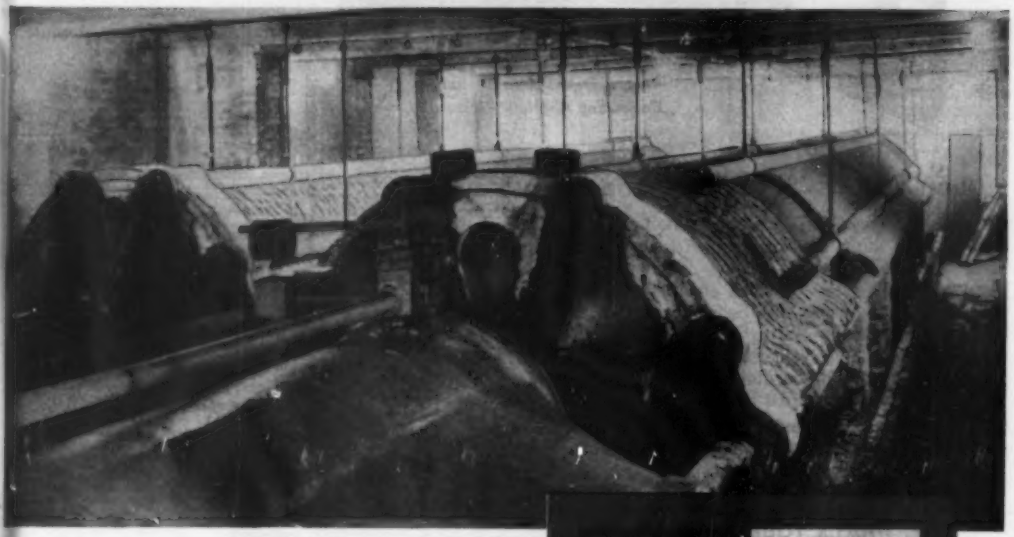
Mt. Vernon-Woodberry's staff of textile engineers is available on request to help you with your problems in development or application of industrial fabrics.



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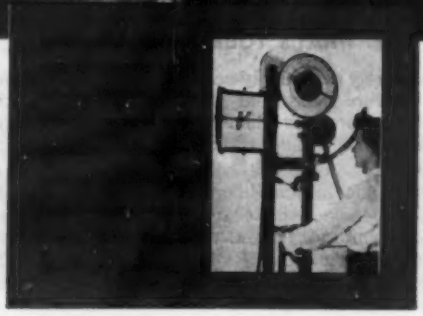

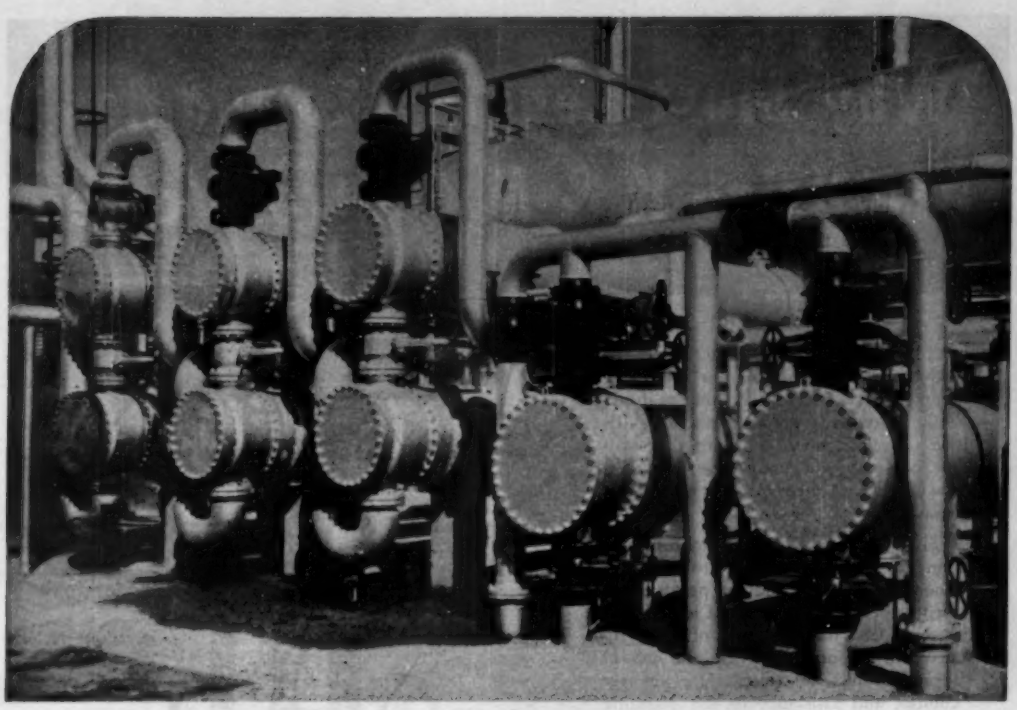

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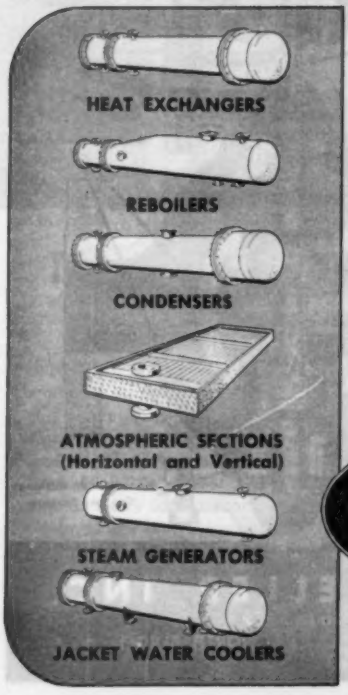

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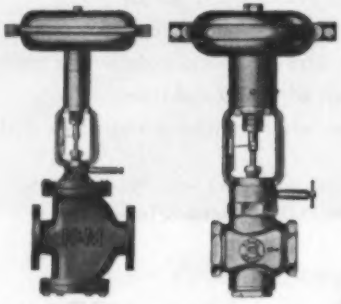
HEAT TRANSFER EQUIPMENT

Why Most Leading Companies Are Using K & M Control Valves

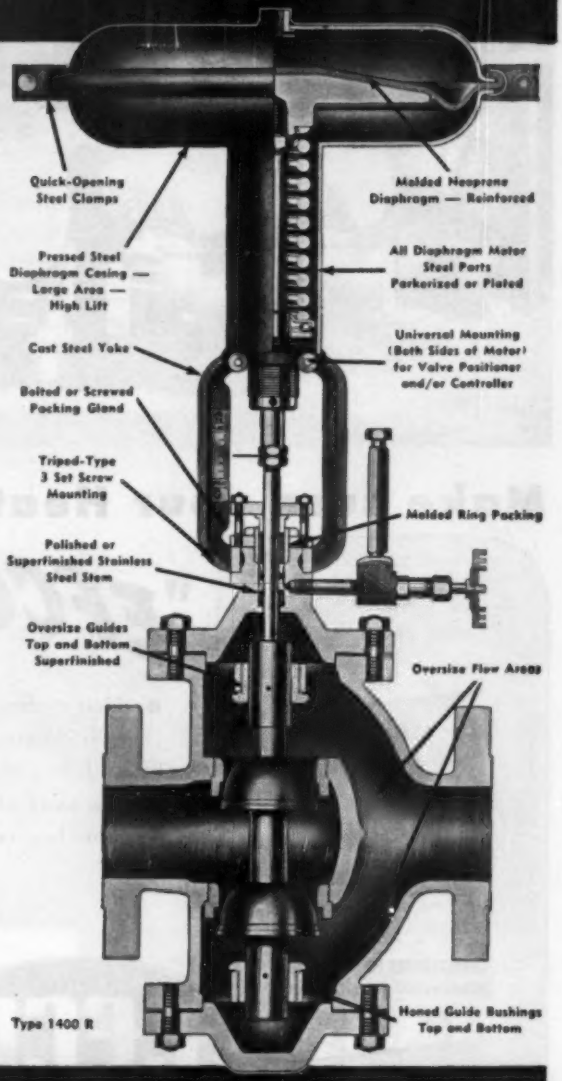
It is logical that leading companies should handle the important subject of control valves as they do other matters: They make use of the best available skills and thinking. More and more, they utilize the equipment, knowledge and facilities of the K & M engineering and service team.

Five years ago, K & M Advanced-Type Control Valves were new to industry. Today, with outstanding performance records behind them, K & M valves have become first in the regard of many instrument engineers. Increasingly, K & M representatives are called upon to give counsel and assistance in the planning of new control installations and the improvement of old ones. During the past year K & M men have been consulted on most of the projects in which control valves have been a major consideration.

There is a qualified K & M representative near you, eager to discuss your problems and able to help you with them.



Type 1200 Type 1000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THE GREER CONTINUOUS WAX MOULDING MACHINE

Introducing Continuous Processing of Liquid Wax into Slabs

NOW in actual operation, and available to the Oil Industry, is this revolutionary machine which receives liquid wax from storage tanks — Deposits in Moulds — Cools to a Solid Slab — and Demoulds ready for shipment — *all Continuously and Automatically, without a hand touching it!*

Pictured above is the discharge end of the machine which occupies a space of only 19 x 78 feet — and produces 12,500 lbs. of finished slabs per hour — with a variation in weight of less than ½ of 1%!

Developed and manufactured by the J. W. Greer Company, who for over 33 years have been solving problems of continuous automatic processing in the Biscuit, Cracker, Confectionery, and Process Industries.

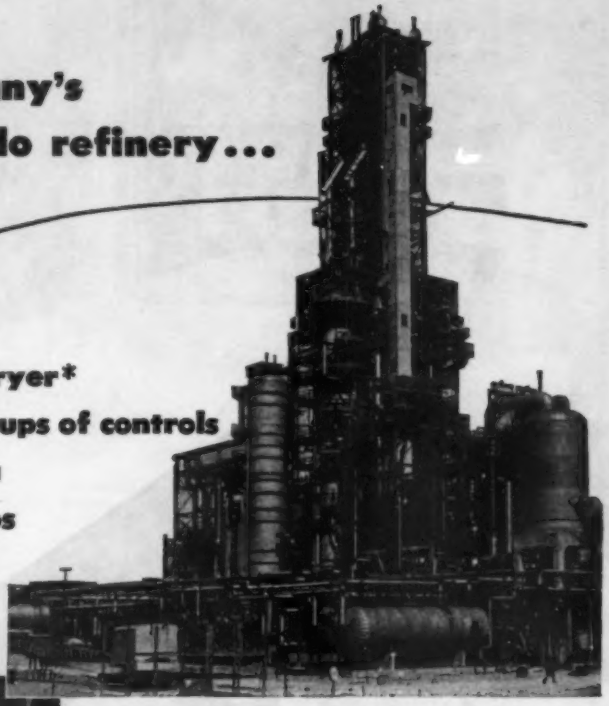
For further information on this really NEW development, send for the bulletin containing specific data on capacities and technical specifications.

GREER

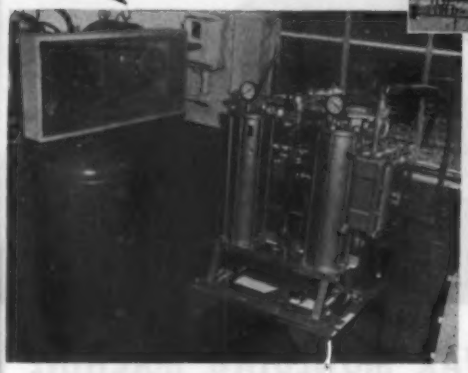
J. W. GREER COMPANY • CAMBRIDGE 39, MASS.

At Sun Oil Company's giant Toledo refinery...

this tiny Lectrodryer* prevents freeze-ups of controls for Susquehanna Pipe Line's pumps



Susquehanna Pipe Line Company's pumping station is located alongside Sun Oil's new Houdriflow unit, capable of producing 600,000 gallons of New Blue Sunoco gasoline daily.



This BAC-O Lectrodryer delivers DRY air to the tank serving instrument air lines.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Glebe, Sydney.
In France: Stein et Roubain, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubain, 320 Rue du Moulin, Bressoux-Liege.

"We had freeze-ups of air lines running to outdoor valves, low-pressure trips and recorders before we installed a Lectrodryer," said the man in charge of this pumping station. "Supplying DRY air to the lines stopped the trouble."

Similar reports come from many phases of the petroleum industry. Air in small volumes, as here, for controlling entire refinery operations; casing head and pipeline gases in huge quantities to prevent valve freeze-ups and corrosion; materials employed in processes to keep involved reactions on the beam—all are DRYing jobs handled by Lectrodryer, dependably and economically.

Standard Lectrodryers meet most DRYing requirements; no need for you to design and build special driers. And Lectrodryer engineers will save you more valuable time by helping you apply this equipment. Write Pittsburgh Lectrodryer Corporation, 307 32nd Street, Pittsburgh 30, Pennsylvania.

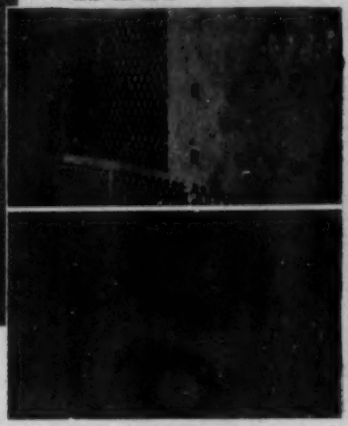
LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

*REGISTERED TRADEMARK U.S. PAT. OFF.

KAST-SET KS-4 being applied by means of a cement gun. Note steel mesh which anchors KAST-SET KS-4 and provides abrasion-resistant wearing surface for Catalytic Regenerator lining.

Application of SK-7 completed. Steel mesh attached to studs preparatory to shooting KAST-SET KS-4.



Interior of Catalytic Regenerator showing the completed lining with the KAST-SET KS-4 applied over the CASTABLE No. 20 SK-7.

A. P. GREEN
SK-7 and KS-4
Two NEW Refractory Castables

Designed and Engineered for "Gun" Application in the Petroleum Field

CASTABLE No. 20 SK-7 — a lightweight insulating castable recommended for a service temperature of 1800° F., and **KAST-SET KS-4** — a castable refractory with a top service temperature of 2750° F. were designed specifically, for cement gun application in the Petro-Chemical industry. This modern method of applying refractory castables greatly reduces labor costs. The A. P. Green Company, a leader in the development and manufacture of high quality castable refractories for normal pouring application, had the experience and engineering know-how necessary in producing these modern pneumatically applied castables.

Continued research, experimentation and improvement have resulted in the development of these gun-applicable refractory castables which afford the same trouble-free service obtained from A. P. Green mix and pour castables. They have gained wide acceptance in the petroleum industry and are specified by several large companies in that field.

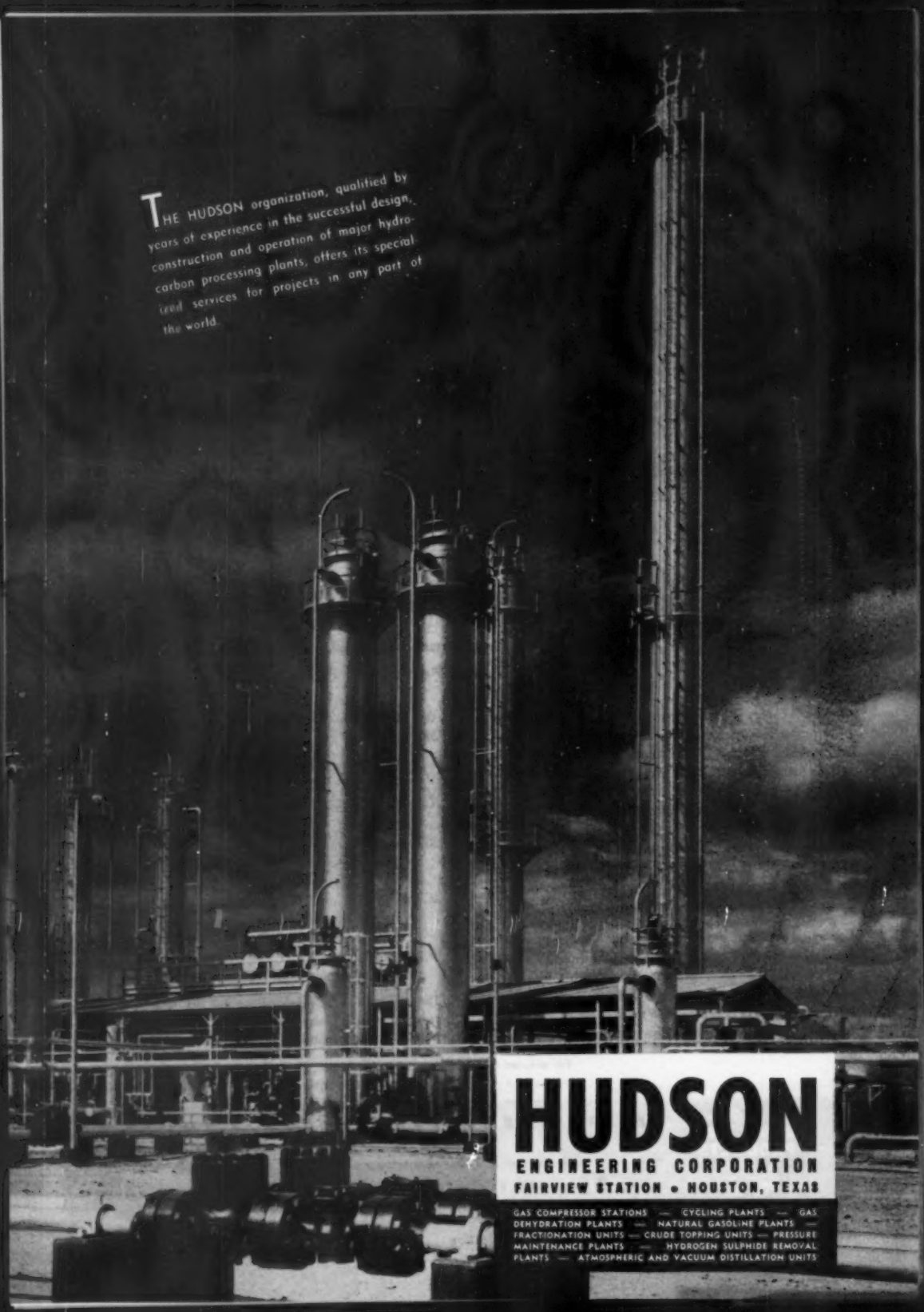
The outstanding advantages available through the use of SK-7 and KS-4 are:

1. Installation time and labor costs are reduced considerably, because these materials can be applied quickly.
2. Construction costs are held to a minimum as no forms are necessary.
3. These castables are adaptable to a variety of installations, particularly in places where normal pouring castables cannot be used.
4. The objectionable feature of many gun-applied materials (high rebound loss) has been corrected by the special compounding of these products.
5. Shooting a lining with SK-7 or KS-4 results in a finished installation having the balanced characteristics of a poured castable.

These materials were designed for use wherever castable refractories are required and in places where the use of normal pouring castables is impractical.

For detailed information concerning these castable refractories, write the Engineering Department of the A. P. Green Fire Brick Company — or call your local A. P. Green Distributor.

A. P. Green
REFRACTORY
PRODUCTS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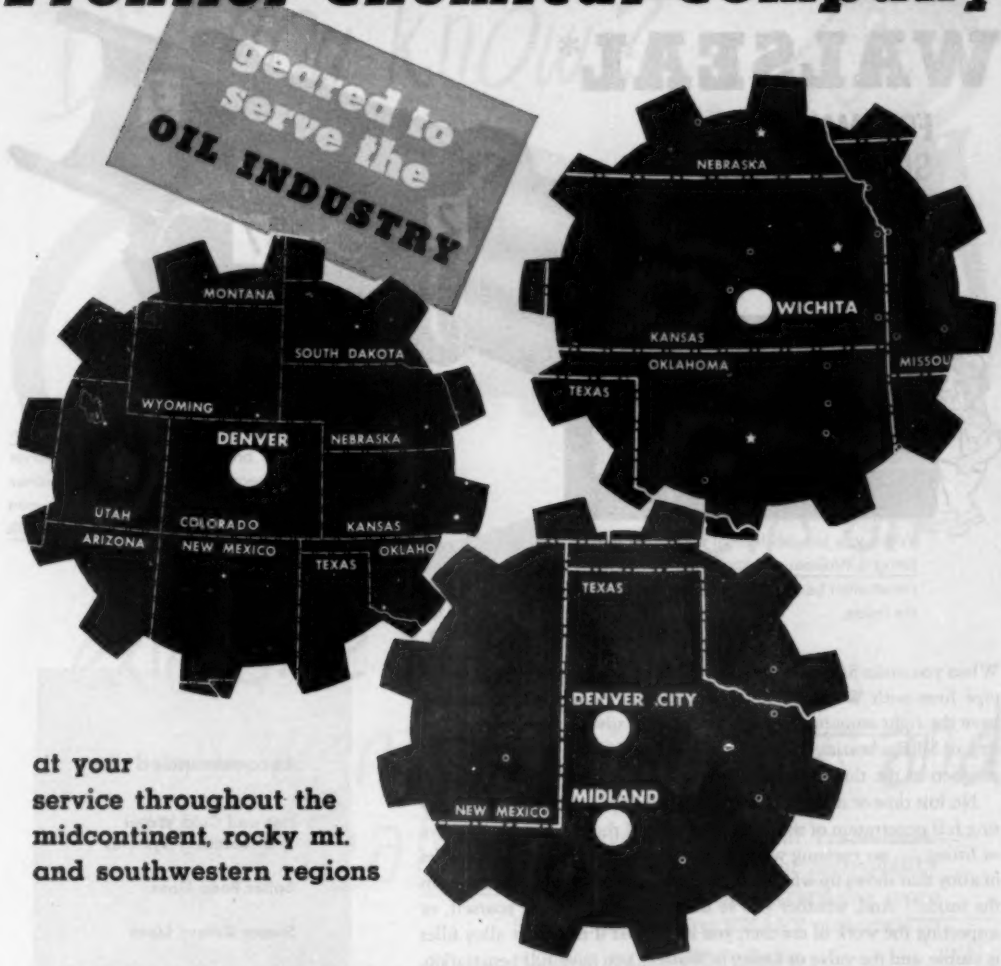

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WALSEAL*

FOR MAKING SILBRAZ* JOINTS

When you see this fillet of alloy, and the fitting is Walseal you know that you have penetration because the alloy comes from the inside.

Cutaway view of a Walseal Tee showing: 1—factory-inserted ring of silver brazing alloy; 2—fillet of silver brazing alloy that appears upon completion of Silbraz joint; 3—cutaway view of the completed Silbraz joint showing that silver brazing alloy has flowed in both directions from the factory inserted ring.

When you make Silbraz* joints in your brass, copper, or copper-nickel pipe lines with Walseal Valves, Fittings, or Flanges you know you have the right amount of the correct type of silver brazing alloy. The ring of Sil-Fos brazing alloy is factory-inserted in the ports of Walseal products at the time of manufacture.

No lost time or motion in handling the alloy . . . no difficulty in getting full penetration of the alloy regardless of the position of the valve or fitting . . . no guessing whether the joint is made right . . . the fillet of alloy that shows up when the Silbraz joint is completed, comes from the inside!! And, whether you've made the Silbraz joint yourself, or inspecting the work of another, you know that if the silver alloy fillet is visible, and the valve or fitting is Walseal, you have full penetration. That's why nobody guesses when you use Walseal!

Walseal products are backed by the reputation of the Walworth Company, manufacturers of valves and pipe fittings since 1842.

For full information regarding Silbraz joints made with Walseal products, write for Circular 84.

*Trademarked—Reg. U. S. Pat. Off.

Recommended for

- Hot and Cold Water Circulating Systems
- Boiler Feed Lines
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valves and fittings

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Secondary Butyl Alcohol	Diisobutylene	Paratac
Isooctyl Alcohol	Polypropylenes	Paranox
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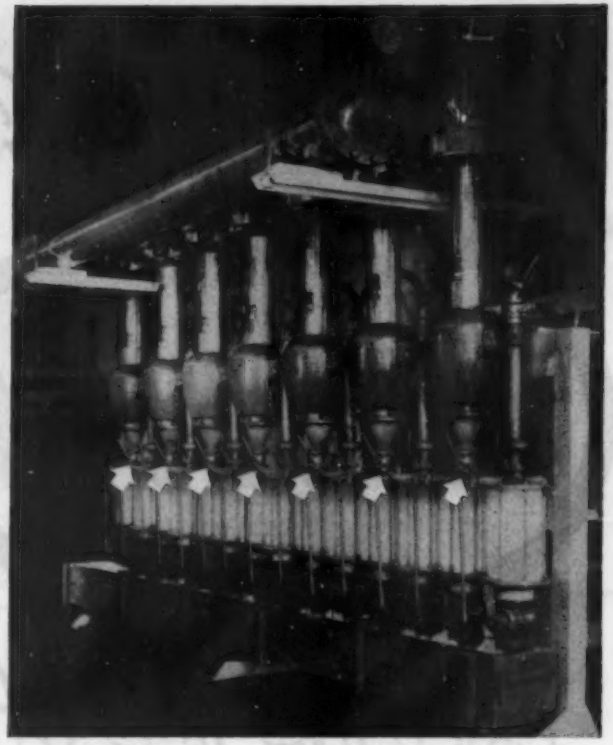
HOW A *Production Wise* MANUFACTURER CUT EXPENSES with ROCKWOOD ball VALVES



The Bird Machine Company of South Walpole, Mass. now equips all Dirtec units (right) with Rockwood Ball Valves to assure papermakers better and longer *trouble-free* valve service. These efficient Dirtec units have won their place in the dirt removal phase of operation in paper mills of all kinds and sizes on the basis of practical demonstrated performance. Rockwood is helping to keep this enviable performance record by producing a ball valve that will operate over and over again without requiring maintenance.

The design engineers of the Bird Machine Company picked Rockwood Ball Valves for the Dirtec units because the valves have features that really help solve today's tough valve operating and maintenance headaches. Once Rockwood Valves are installed, valve troubles stop! Every Rockwood Valve is easy to install and operate — constantly dependable.

Rockwood Ball Valves are designed and engineered for the tough piping jobs. Equip your plant and machines now with Rockwood Valves — the valve that increases production by cutting maintenance cost.

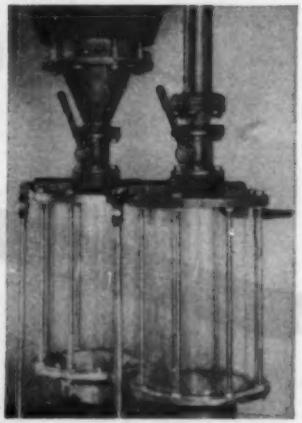
Thousands of Rockwood Ball Valves are giving efficient and economical service in oil refineries, food, paper, textile, chemical and rubber plants, etc. Rockwood Ball Valves are available in all pipe sizes from ½" to 4" and are recommended for 300 p.s.i. working pressure.

Write today for illustrated booklet V-4. Distributors in all principal cities.

7 *Good Engineering* Features Why Rockwood Ball Valves Will Do The Job Better...

1. Full *round* open area — no turbulence in fluid stream. **2.** Leak proof after continued use. **3.** New floating ball — resists pitting, scratching and abrasion. **4.** No exposed seating surface in open or closed position. **5.** Easy to open or close under full pressure. **6.** Installed in any position. **7.** Quarter turn (90°) opening and closing valve.

Picture below shows close-up of the latest design of Dirtec. Rockwood Valves isolate the body of the Dirtec from the sump in which the dirt collects. At bottom of sumps, a 2" Rockwood Valve is used for dumping the dirt.



ROCKWOOD SPRINKLER CO

102 HARLOW STREET WORCESTER 5, MASS

Zallea Expansion Joint News

PUBLISHED BY ZALLEA BROTHERS—WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS EXCLUSIVELY

Expansion Joint of the Month

LOW PRESSURE TYPE

The Zallea Low Pressure Corrugated Expansion Joint is used to absorb vibration and protect machinery. Made of stainless steel, these joints are of the non-equalizing type and are limited in

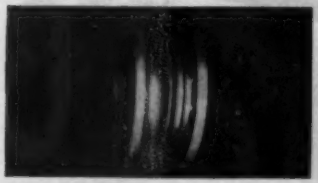


Figure 7

Figure 8

service to ½" maximum axial movement and 50 lbs. maximum working pressure. Furnished with a single corrugation (Figure 7), or with multiple corrugations (Figure 8), they are primarily used on condensers, turbines, stage bleeders, pumps, and between connected equipment where slight movement and vibration occurs. Industry, with its increasingly high temperature problems, relies on the Zallea Low Pressure Corrugated Expansion Joint for smooth flow and maximum operating performance. For your expansion problem, always specify the *best* in expansion joints . . . specify *Zallea*, you'll find it pays!

. . . a brand new 4-page folder on *all* Zallea Expansion Joints. Send for your copy of Bulletin 351 today!

ZALLEA BROTHERS, 890 Locust Street, Wilmington 99, Delaware.

OPERATION D-E-E-P FREEZE

Our Readers Ask

Q. *A friend and I recently had a friendly argument over copper vs stainless steel expansion joints. What are your views? A. T. M., Conshohocken, Pa.*

A. Except where corrosive conditions prevent, stainless steel may be used wherever copper is used. Although slightly more expensive in its initial cost, the use of stainless steel will result in much lower overall cost because of its increased life. Having approximately three times the tensile strength of copper, stainless steel elements can be made with a wall thickness approximately ⅓ that required for copper to withstand the same working pressure. As the life of a corrugated element varies inversely with the thickness of the element, a stainless steel expansion joint will last several times longer than a copper expansion joint designed for the same operating pressure.

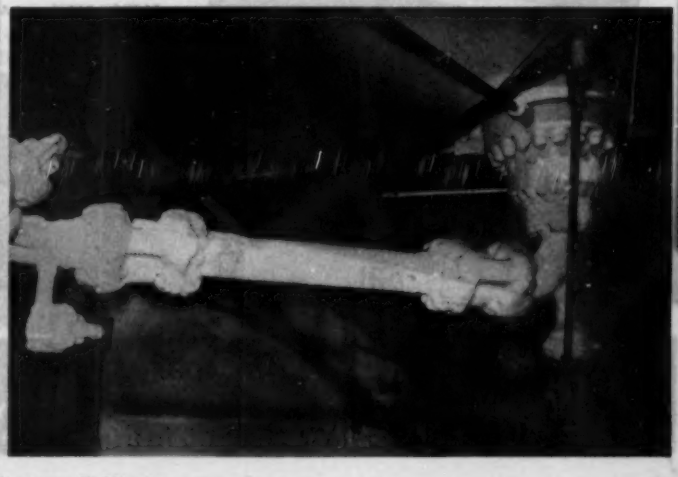
Your questions are welcomed. Address all letters to Engineering Dept. 017.

Temperature and Pressure Problem Solved by Zallea

Recently Zallea engineers were faced with a problem of developing expansion joints for operation on a liquid oxygen line, operating at —320° F., under extreme pressure at a large classified government facility. Because of the unusual nature of this installation, Zallea engineers designed *both* the piping layout and the expansion joints. Special stainless steel alloys were selected for the expansion joints to withstand the severe operating conditions.

Zallea Joints Tested

Shown here in operation, under a heavy layer of frost, are two of a group of 14 six inch Zallea Toroidal Hinged Type Stainless Steel Expansion Joints, with stainless steel construction throughout including the hinges and flanges. Prior to shipment, these Zallea Stainless Steel Expansion Joints were factory-tested to 1400 pounds hydrostatic pressure for a period of 8 hours to insure long life and satisfactory job performance.



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Top quality power and process plant equipment for safe operation at high or low pressures and temperatures is produced here for leading Petroleum Refineries, Chemical Plants, and Power Plants the world around.

A growing preference for Vogt welded pressure vessels is due to skilled personnel, powerful X-ray apparatus to control weld quality and modern stress relieving furnaces, combined with complete laboratory facilities for tests of welds.

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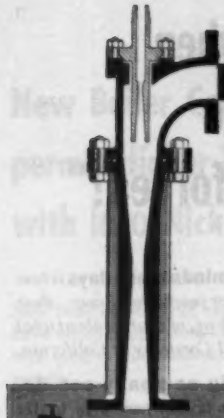
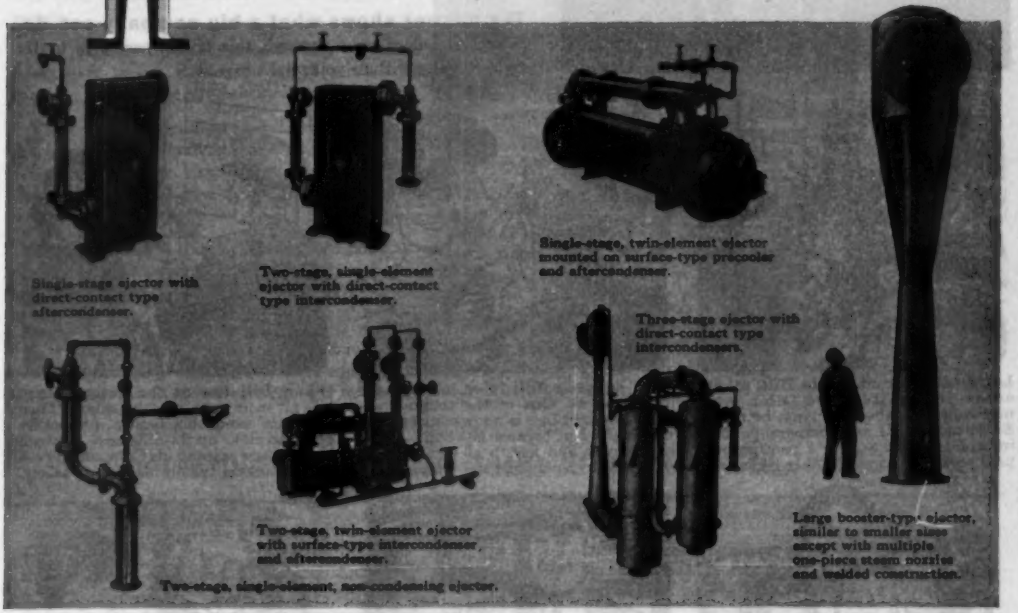


.002" (50 microns)

YOU CAN SAVE

operating and upkeep costs WITH I-R STEAM-JET EJECTORS


Single-stage ejector with direct-contact type aftercondenser.
Two-stage, single-element ejector with direct-contact type intercondenser.
Single-stage, twin-element ejector mounted on surface-type precooler and aftercondenser.
Three-stage ejector with direct-contact type intercondensers.
Two-stage, twin-element ejector with surface-type intercondenser and aftercondenser.
Two-stage, single-element, non-condensing ejector.
Large booster-type ejector, similar to smaller sizes except with multiple one-piece steam nozzles and welded construction.

Whatever the capacity—whatever the gases or vapors to be handled—Ingersoll-Rand steam-jet ejectors can generally do the job far more economically than any other type of equipment. Their utter simplicity of design and operation assures long life and sustained high efficiency, with practically no maintenance at all.

Suction pressure is obtained by a steam-jet discharging into a specially formed suction chamber and venturi-shaped diffuser. That's all there is to it. There are no moving parts to wear out—no excessive noise—no vibration. Ejectors can be installed anywhere, with little or no foundation, and can be operated by inexperienced personnel.

Single-stage, two-stage and multi-stage ejectors can be supplied in any required combination—with pre-coolers, intercondensers and aftercondensers to meet the specialized needs of practically any application for suction pressures down to 50 microns (.002" Hg absolute).

Ingersoll-Rand's unequalled experience in vacuum equipment—both steam-jet ejectors and reciprocating pumps—is your assurance of impartial service in meeting your low-pressure requirements. For further information, contact your nearest I-R representative, or write for a free copy of Bulletin 9013A.

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TURBO-BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS
DIESEL & GAS ENGINES

"What happens when Standard men go into the armed forces?"

One question on many people's minds these days *is how military service may affect themselves or people they know...their jobs, their family security. People ask us, of course, about what happens to employees of Standard Oil Company of California.*

The answer shows what a big company can do. Standard Oilers come through this trying period in better financial shape than you might expect:

Let's take for example Bill, an average young Standard Oiler. As a mechanic with the Company, he makes $368 a month. He has Company-paid life insurance worth $4,420, a pension plan paid partly by himself, other benefits.

Now suppose Bill is called into the armed forces. One of the tough problems he might face is a lower income for his family. But because he qualifies as to dependents and length of service, he'll be helped by a plan Standard has for him.

When Bill leaves for active duty, he's given an extra month's salary. Then Standard sends his family a monthly check to make up the difference between his military pay and his Company pay—an amount up to half his regular salary.

Moreover, Bill's Company life insurance remains in force—still paid for entirely by Standard. And the pension plan, which Bill paid for in part while he was working, continues to grow—but now Standard of California pays it all.

When Bill comes back from military service his job is waiting . . . his benefits intact. Standard, having big *economic* resources, can and does act to preserve the *human* resources of the nation . . . people like himself and his family.

This is Standard's "G.I. Policy" for qualified employees called into the Armed Forces. We believe it helps strengthen Company morale and that of the nation, too—another way Standard serves best by being a big company.

I'd Like to Know . . . Many people write to Standard asking pertinent questions about the Company. We answer all letters individually, but some points seem of general interest. We take this way of discussing them for every one. If you have a question, we urge you to write in care of: "I'd Like to Know," 225 Bush Street, San Francisco 20, California.

STANDARD OIL COMPANY OF CALIFORNIA

• plans ahead to serve you better

New Boiler Code Rulings permit Higher Temperatures with INCO Nickel Alloys

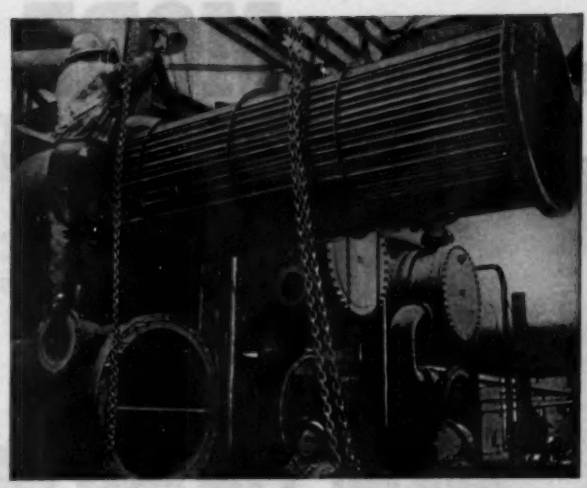
New interpretations of the A.S.M.E. Boiler Code have raised temperature limits on INCO Nickel Alloys used in the construction of unfired pressure vessels.

Also, in addition to annealed Monel, it is now permissible to use stress-relieved Monel, which has substantially higher mechanical properties.

These two modifications of the code mean that it is now possible to build stronger and lighter heat exchangers for higher temperature service, *that are insurable because they are built to code requirements.*

But this modified code applies only to physical properties. To overcome corrosion troubles, users must assume the responsibility for choosing the correct materials.

A glance at the table will show how some users have been able to get greatly increased equipment life by the proper choice of heat exchanger metals...



A cleaned exchanger tube bundle being replaced in its shell. "Spring-cleaning" like this prevents failures in service and insures efficient heat exchange. *Photo courtesy The M. W. Kellogg Co., New York, N. Y.*

Right now, INCO Nickel Alloys are being diverted more and more to defense production. This means you may have to wait to get Monel. But it doesn't mean you have to wait to find out whether our Corrosion Engineering Service can help you. Simply write — and outline your problem.

And at the same time, ask for a free copy of the new "Boiler Code Interpretations Involving Nickel, Monel, Inconel." It lists the new stress and temperature limits for the INCO Nickel Alloys.

OPERATING HISTORIES OF MONEL HEAT EXCHANGER TUBING

Case No.	Products Handled		Highest Temperature	Service Life		
	Inside tubes	Outside tubes		Previous Material	Monel tubes	Condition of Monel at last inspection
1	Steam	Caustic	350	2-8 weeks	17 months	Good—still in service
2	Foul Caustic	Steam	300	5 months	25 months	No evidence of corrosion
3	Heavy recycle	Straight run gasoline distillate	550	6665 hours	38,535 hours	Renewed 24 tubes after 22,000 hours—3 tubes plugged at 38,535 hours. Remainder OK.
4	Caustic soda and sodium chloride	Steam	240	10 months	80 months	Good—15 tubes replaced—weld failures
5	Crude oil	Gasoline vapor	300	6-8 months	48-60 months	No inspection

Service information on heat exchangers closely similar to yours is probably not in this table. However, help is available from INCO'S Corrosion Engineering Service. From their thousands of data sheets showing corrosion rates in a wide variety of media, it is likely that an answer to your specific problem can be found.

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Monel® • "R"® Monel
"K"® Monel • "KR"® Monel • "S"® Monel
Nickel • Low Carbon Nickel • Duranickel®
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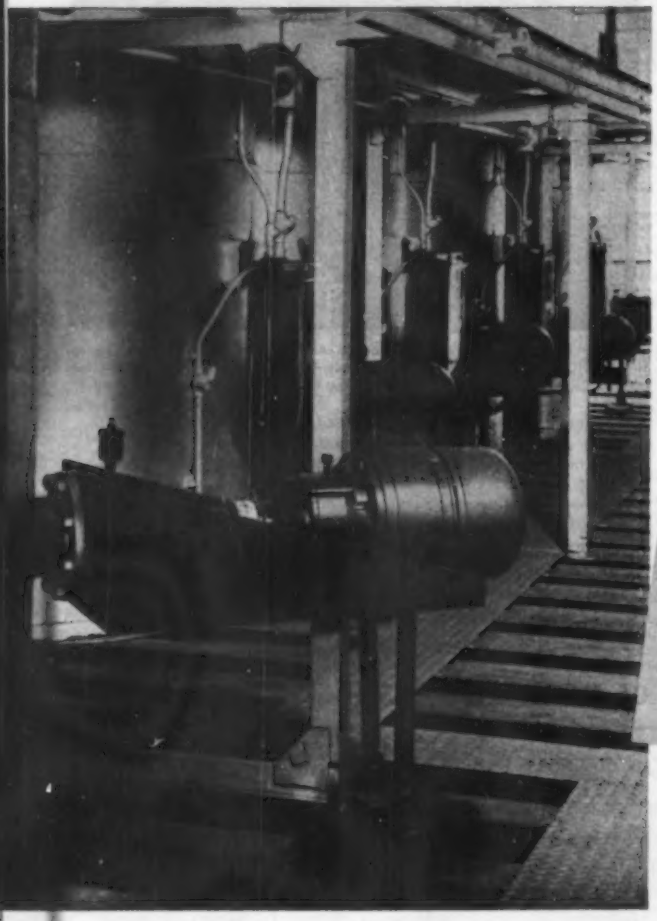
Same Plant... MORE PRODUCT



Lightnin Mixers help you *step up production* from your present plant.

Lightnin Mixers speed up the important mixing and blending operations . . . doubling *and even tripling* the number of batches your tanks can handle.

MIXCO technology has solved fluid agitation problems for thousands of processors. Many Lightnin Mixers have been in service 20 years and more. Every Lightnin is *guaranteed* to do the job!

Call in your MIXCO representative today —or write us for details on Lightnin Mixers.

LIGHTNIN Installation
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OPERATION: Lube oil blending
TANK: 10,000-gallon vertical cylindrical
AGITATION: One 7½-HP Lightnin Mixer, side entering type
BLENDING TIME: 20 minutes

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- ☐ B-102 Top Entering Mixers (Turbine and Paddle Type)
- ☐ DH-50 Laboratory Mixers
- ☐ B-101 Condensed Catalog showing complete line
- ☐ B-75 Portable Mixers (Electric and Air Driven)

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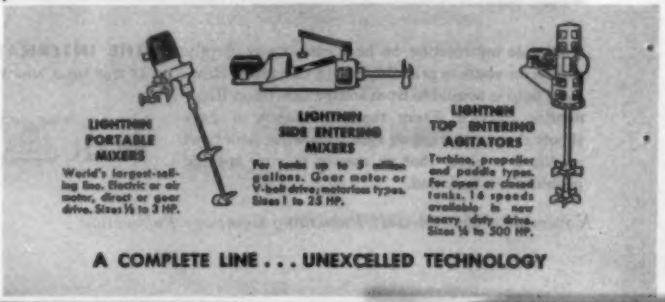
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PETROLEUM REFINER

The LOOK BOX

Alkylation Expansion Pushed

LONG-RANGE PLANS of the Defense Department and Petroleum Administration for Defense to encourage rapid expansion of facilities for producing alkylate for aviation gasoline by private industry have been given the green light.

The object of the program is to boost alkylate capacity by 25 percent by 1954, from the present 127,000 barrels per day to about 158,000 barrels daily. Government planners hope to get the increased capacity by inducing refiners (presently 35 produce alkylate) to invest upwards of $80 million of their own money for the construction of 26 new alkylation plants and for the rehabilitation of five government-owned plants. To encourage the construction of these plants, the government would sign a "facilities contract" with interested refiners for a five-year maximum term, which would guarantee the builder no loss on the investment.

Specifically, this would be accomplished by contracts with the Armed Forces Petroleum Purchasing Agency of the Defense Department upon PAD recommendation of any proposed plant. Petroleum Purchasing Agency already has invited all refiners to furnish it with any preliminary data on plans for revamping present alkylation plants or for the construction of new facilities. After PAD has approved any proposed plant, the Petroleum Purchasing Agency would then make a contract under which the refiner would complete his construction program and agree to operate the plant for five years or to hold the facilities in standby condition for immediate use when necessary.

Under the general plans of the proposed plants, the Defense Department presently plans to sign contracts to purchase specified amounts of either raw alkylate or blended aviation gasoline at prices that would allow the plant to earn back its normal depreciation plus a reasonable profit, estimated at about 5.2 percent. Such purchase contracts would be for one-year terms and should they not be renewed and the owner decides not to continue operating the plant for his own use, the government would either end the original facilities contract by reimbursing the refiner for unrecovered investment costs, or agree with the operator to keep the plant on standby for the remainder of the five-year original facilities contract term.

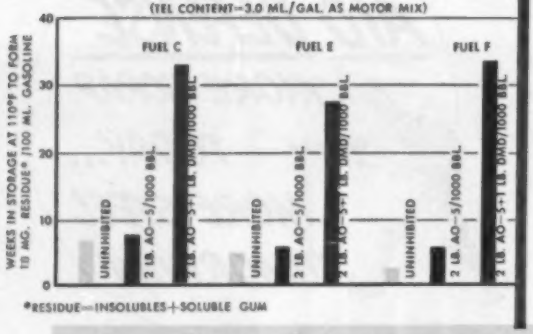
Supply-Demand Forecast Revised

TOTAL REQUIREMENTS for U. S. petroleum this year will run higher than had been anticipated at mid-year due to mounting export shipments, though estimates of domestic demand have been lowered slightly, according to the latest revised forecast of the U. S. Bureau of Mines. Over the long run the agency predicts the trend of expansion of oil demand to continue into 1952 with an indicated first quarter demand of 8,140,000 barrels daily, an increase of 5.2 percent over actual consumption in the like 1951 period.

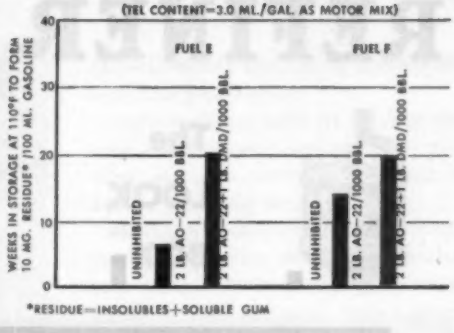
Combined domestic and export demand for the full year 1951 is now expected to reach a new peak daily average of 7,490,000 barrels, up 687,000 barrels, or 10.1 percent, over the 1950 average and 38,000 barrels a day above the Bureau's June prediction. The Bureau of Mines' newest estimate of domestic demand gives some confirmation to a trend of slipping consumption within the U. S. that has been forecast by some industry economists. Total requirements for the U. S. for the full year are placed at a daily average of 7,101,000 barrels, a reduction of 77,000 barrels, or about 1 percent, from the government agency's previous forecast. Domestic demand now is expected to average 9.3 percent above 1950, compared with an increase of 10.4 percent estimated earlier.

Anticipated export demand for crude and products has been boosted sharply to 389,000 barrels a day for the full year, up 42 percent over the earlier expectations and 27.9 percent higher than

EFFECT OF DU PONT METAL DEACTIVATOR IN COMBINATION WITH ANTIOXIDANT No. 5 IN 3 GASOLINES


(TEL CONTENT—3.0 ML./GAL. AS MOTOR MIX)
WEEKS IN STORAGE AT 110°F TO FORM 10 MG. RESIDUE* /100 ML. GASOLINE
FUEL C
FUEL E
FUEL F
UNINHIBITED
2 LB. AO—5/1000 BBL.
2 LB. AO—5+1 LB. DMD/1000 BBL.
*RESIDUE—INSOLUBLES+SOLUBLE GUM

EFFECT OF DU PONT METAL DEACTIVATOR IN COMBINATION WITH ANTIOXIDANT No. 22 IN 2 GASOLINES


(TEL CONTENT—3.0 ML./GAL. AS MOTOR MIX)
WEEKS IN STORAGE AT 110°F TO FORM 10 MG. RESIDUE* /100 ML. GASOLINE
FUEL E
FUEL F
UNINHIBITED
2 LB. AO—22/1000 BBL.
2 LB. AO—22+1 LB. DMD/1000 BBL.
*RESIDUE—INSOLUBLES+SOLUBLE GUM

COMPOSITION, COPPER CONTENT, AND DEACTIVATOR RESPONSE OF TEST FUELS CITED

FUEL COMPOSITION

	Composition, vol. %		
	Fuel C	Fuel E	Fuel F
Catalytic cracked gasoline	30.0	46.0	75.0
Thermal cracked gasoline	13.4	32.0	5.0
Straight run gasoline	56.6	22.0	—
Natural gasoline & light ends	—	—	17.0
Thermal reformed gasoline	—	—	3.0
Copper content p.p.m. by wt.	0.04	0.03	0.05

INDUCTION PERIOD RESPONSE TO METAL DEACTIVATOR

Metal Deactivator Concentration, wt. %	Induction Period, min.		
	Fuel C	Fuel E	Fuel F
None	1078	404	971
0.0001	1159	398	1036
0.0003	1174	407	1035
0.0005	1171	406	1029
0.0008	1170	401	1030

DUPONT METAL DEACTIVATOR STEPS UP STORAGE STABILITY OF MANY GASOLINES

There is a good chance that copper is present in your gasoline whether any of the components have been copper sweetened or not. Recent tests at the Du Pont Petroleum Laboratory, for example, show that 64 out of 91 samples of gasoline components tested contained copper.

Since an antioxidant alone does not always provide the required stability over extended storage periods when copper is present, the use of an economical additive such as Du Pont Metal Deactivator *in conjunction with the antioxidant* is recommended.

The above data illustrate the point. As the charts show, with only 1 lb. of Du Pont Metal Deactivator per 1000 barrels added to antioxidant inhibited gasolines stored at 110° F., the stability period increased from 6-8 weeks with antioxidant alone, to 28-34 weeks with Metal Deactivator added, before reaching a 10 milligram residue level.

If you are interested in insuring the storage stability of your gasoline at a minimum cost, we suggest, for more accurate results, you use storage tests rather than accelerated tests to determine the value of Du Pont Metal Deactivator combined with Du Pont Antioxidants in your stocks.

For samples or further information get in touch with your Du Pont representative.

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IN CANADA: Canadian Industries Limited—Toronto, Ont.—Montreal, Que.

the 1950 daily average of 304,000 barrels. The overall increase is almost entirely made up of greater need for refined products in world markets due to the shutdown of the Abadan refinery of Anglo-Iranian Oil Company. According to the Bureau's calculations, the peak export demand was reached in the third quarter at a daily average of 465,000 barrels of crude and products; and total exports in the current quarter will recede to an average of 391,000 barrels a day.

Daily average crude runs to stills have been revised upward by the bureau to 6,510,000 barrels for the year, 771,000 barrels or 13.1 percent, over the 1950 average and 89,000 barrels daily over the mid-year forecast for 1951. Refinery runs in the current quarter are estimated at an average of 6,609,000 barrels per day, compared with actual runs of 6,492,000 barrels a day in the first quarter, 6,398,000 barrels daily in the second and 6,538,000 barrels a day in the third quarter.

Opportunity and the Men

THE DEVELOPMENT of industry in America since the turn of the century makes reading that challenges the imagination of all persons who think. Typical of this almost overnight growth is The Dow Chemical Company whose saga adds a brilliant chapter to the over-all account of a development that has made the American way of life and the American standard of living what it is today.

Recently before a group in Houston Leland I. Doan, a Dow official, told this story again and the Houston business men who heard him came away from the gathering with a mixed feeling of wonderment, and thanksgiving. It's great, they told each other, to live in a country that can furnish the background for such pulsating industrial growth and creative progress.

The story is too long to detail here, but what Dow did during the dark days of the depression is characteristic of the spirit that has motivated the company and has brought it to the commercial heights it enjoys today.

By 1930 The Dow Chemical Company had a wide range of products and sales approaching $20 million. Herbert Dow died that year and this sad event was followed shortly afterward by the crippling blows of the economic crash of that period. His son, Willard Dow, stepped into the presidency.

Diversification helped to sustain the company through this period but further diversification was agreed upon and aggressively carried out as was "an almost arbitrary policy of progress rather than retrenchment" which helped to bring the company —and the country—out of the depression. By 1939 Dow had assets of nearly $40 million and sales of nearly $27 milion.

It was during this same decade that the corporation's outlying divisions, subsidiaries and associated companies were formed. And intensified research, which was another phase of Dow's depression program, resulted in many new lines which have since become important. The best example of this is plastics—developed in the 30's, retarded by World War II, but accelerated since until this past year they accounted for more than a fourth of the company's sales.

Also at the end of the depression the company embarked on its Texas project of producing a greater quantity of magnesium from sea water. The part that this development had in winning World War II is a separate and thrilling story. Dow's styrene process was another result of the company's depression-period plastics research.

This is but a bite of a full seven-course meal that anyone can enjoy by reading the full Dow account. It makes one thankful that he lives in a land where there is opportunity for such development and, what is more important, the kind of men who dream and, what is more important, men with the energy, the foresight and the perseverance to turn those dreams into realities.

Effect of Abadan Shutdown

THE LOSS OF IRANIAN oil is not a disaster for the nations of the free world chiefly because of the vitality of the American oil industry working under the competitive enterprise system. This is the view of A. L. Nickerson, a director of Socony-Vacuum Oil Company, Inc.

"Already the crude oil lost in Iran has been made up by increased production in the United States itself, in the Middle East and in South America," Mr. Nickerson said. "The loss of the refinery at Abadan presented a greater problem, but that is being met by increased operating rates at present refineries and by building up refining capacity both in the U. S. and in Europe."

Mr. Nickerson warned, though, that the problem is "not completely licked." In contributing substantially to making up for the loss of Iranian oil, he explained, the United States has reduced the margin between its own crude oil producing capacity and actual production and is operating its refineries close to maximum rates.

"It appears to us, however, that demands will be met this coming winter, although the supply and demand relationship may become rather tight if Abadan stays down and if our own domestic demand continues to increase," he asserted.

Despite the phenomenal accomplishments of petroleum research, much still remains to be done, Mr. Nickerson declared. "There are some 82 billion barrels of crude oil underground in fields already discovered, that can be recovered only by better methods than we know now," he said. "If we can recover eight out of ten of those barrels, we'll have an amount greater than all the oil produced in this country in the past 90 years. I believe that our researchers and engineers eventually will find a way to do it."

Double Trouble for coke deposits!

...with the Lagonda 1100 Series Tube Cleaners

Meet the scrappy combination that has made the '1100' a byword in the industry for fast, thorough cleaning of refinery still tubes . . . The combination that cuts 'down time', gets you back on stream faster, and reduces maintenance costs on still tubes.

❶ **LAGONDA 1100 SERIES MOTOR** High-speed, heavy-duty; all wearing parts of alloy steel, precision ground to give maximum efficiency over a long life. BALL thrust bearings at both *front* and *rear* of motor plus exclusive Lagonda pressure lubrication insure smashing power to cutter head for faster, more thorough cleaning – saving costly minutes and hours in 'down time'.

❷ **LAGONDA CUTTER HEAD** Tough on coke deposits, tender on tubes. Patented trackless design of cutter teeth results in each tooth contacting at a slightly advanced point at each revolution, removing all encrustation without cutting tooth design in tube wall. Keen, long-lasting edges of cutter teeth and ability of entire unit to take repeated hard blows without failure are attained through the use of selected alloy steels and expert heat treatment. Simplicity of construction gives utmost ruggedness yet permits easy disassembly for repair.

IF IT'S TUBE CLEANING IT'S Lagonda

BULLETIN Y-29 contains complete details and specifications on the full line of Lagonda Tube Cleaners. Write for your copy today.

Y-302

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View of Modern Installation, South Coles Levee Unit Cycling Plant, Kern County, California

The Natural Gasoline Industry And Petroleum Progress

T. S. PETERSON

President, Standard Oil Company of California, San Francisco

THE oil industry as a whole, in all its ramifications—economic, technological, physical size, distribution problems and all the rest—is one of the most complicated to be found in the modern industrial system. And the natural gasoline business, a world of its own in world of oil, has elements of all this complexity because it is so important in so many of the industry's operations.

Your business consists of big, medium and small operators, just as you find elsewhere in the oil industry. Your problems frequently are unique, but at the same time they must be related to the problems of the oil industry as a whole. Working together, we know we can solve them to our mutual benefit and to the benefit of our country.

No little part of the petroleum story should revolve around the activities of the California Natural Gasoline Association, because the importance of its operations grows daily. New demands for better fuels and the continued expansion of the general use of petroleum products are directly reflected in this business. Yet, few outside the oil industry know the great contributions liquid petroleum gases have made to better driving, better living and to our national defense. Few know that natural gasoline is a $500,000,000 yearly industry in the American economy.

LPG products are a relatively new part of the oil industry. Twenty years ago there were virtually no commercial uses for the liquefied petroleum gases—the butanes and propane—which now are so vital. When they were cracked out in the refinery, they were fed into the refinery boilers. They were not extracted in the field, but, instead, permitted to go over the top into natural gas.

From what is known today, that was a deplorable wastage of these valuable products. But, because of oil field overproduction and lack of knowledge, waste was added on waste. There was flared or otherwise dissipated colossal quantities of natural gas, containing the LP components.

The men of responsibility in the oil industry in those days in California knew the immediate and future consequences of this prodigal destruction of irreplaceable natural resources. They backed far-sighted legislators in obtaining passage of California's Natural Gas Conservation Act of 1929, which declared that "the unreasonable waste of gas" was unlawful.

"When the law was passed, it was estimated that the wastage of gas in California was 400,000,000 cubic feet a day and, subsequently, this wastage increased to more than double that amount," the Saturday Evening Post said. "There was waste more prodigal than the world had ever known before. In terms of fuel oil, this wastage was equivalent to 132,000 barrels a day."

Terrific Waste

On the basis of that 132,000 barrels a day burned and blown into the air, nearly every fourth year we were throwing away the equivalent of a full year's requirements of liquid fuels for the entire Western area of the U. S. Estimates are that 38 percent of natural gas production in California was wasted between 1920 and 1930.

Or, it has been estimated that in the years through 1928, 1½ trillion cubic feet of gas was flared in California. In 1950, about 670 billion cubic feet was used in California as fuel. Roughly, then, the state had flared about 2½ years of its present natural gas requirements.

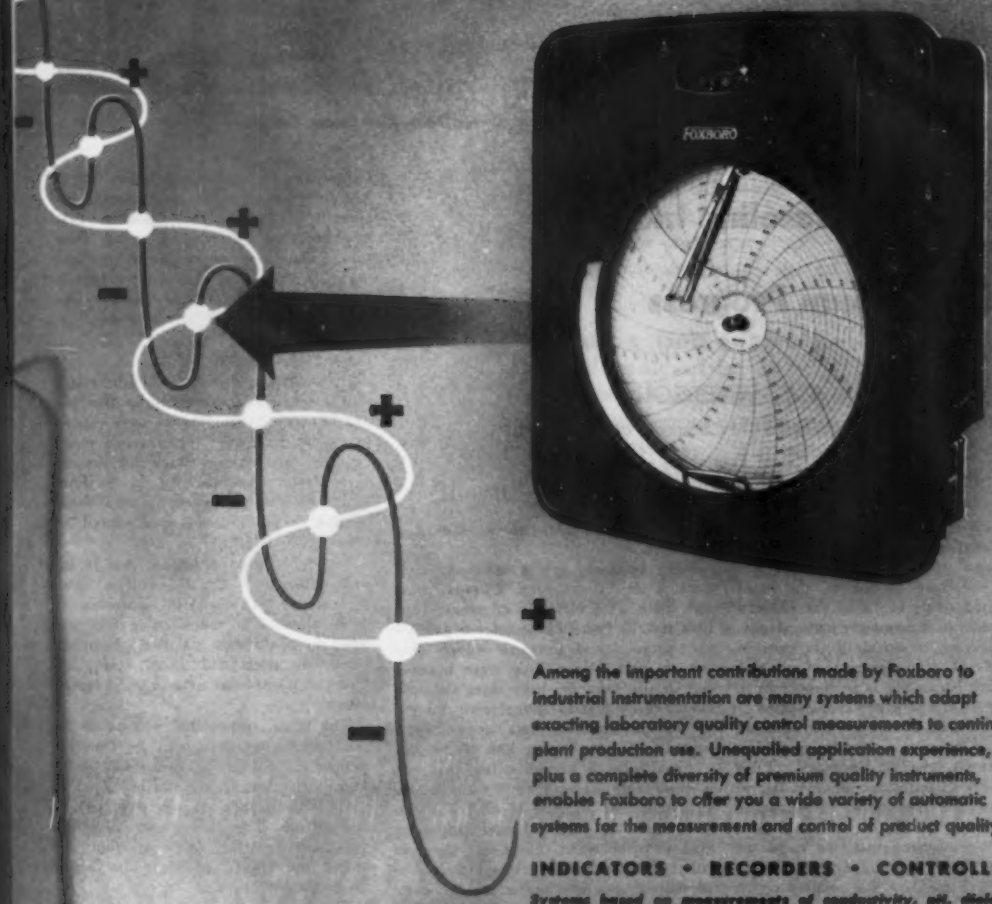
The large, responsible portion of the oil industry which wanted to conserve petroleum and gas resources had priceless cooperation from the utilities, which spread their markets for the use of natural gas. The oil industry meantime searched for uses for what might be called the "plus" products that could be extracted from it.

So it was that my company, soon joined by others, began to look about for ways to use butane and propane, and the bottled gas business came into being.

Word of the miracle of this new product quickly spread and cordwood and the kitchen wood stove began to be things of the past in rural homes and in places remote from the big city gas systems. With the exception of electricity, there is nothing that has equalled the use of these light products in les-

better instrumentation for

QUALITY CONTROL



Among the important contributions made by Foxboro to industrial instrumentation are many systems which adapt exacting laboratory quality control measurements to continuous plant production use. Unequalled application experience, plus a complete diversity of premium quality instruments, enables Foxboro to offer you a wide variety of automatic systems for the measurement and control of product quality.

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sening farm household burdens.

As time went on, we found we could use butane to better advantage elsewhere than as a simple fuel and so the more volatile propane, using a little heavier cylinders and other equipment has come into its own. It was found that a mixture of butane and propane—Bu-G—made a marvelous fuel for certain types of internal combustion engines.

By the end of the 30's, we knew we had something big in the field of light products: supplies for local gas distribution plants, chemicals, synthetic rubber, a host of commercial and industrial applications, better gasolines. And, with the history of the oil and gas industry to provide experience, we knew that each new use would bring about a dozen others.

The Western demand charts, steadily moving upward, with scarcely a dip, tell the story of the development of the use of LP-Gas for better living. In District 5, each new year has been a virtually new chapter in this progress. In 1932 the demand was a mere 500 barrels daily. But, 1940 was up to 5000 barrels, 1945 up to 12,000 and this year will show about 25,000, including some 2500 barrels daily of normal butane for the butadiene process.

Varied Demands

Equally interesting are the facts as to where the various demands lie.

Domestic and commercial usage, including household tasks and small businesses (bakeries, restaurants and resorts) has jumped from 1000 barrels daily in 1939 to 12,500 last year.

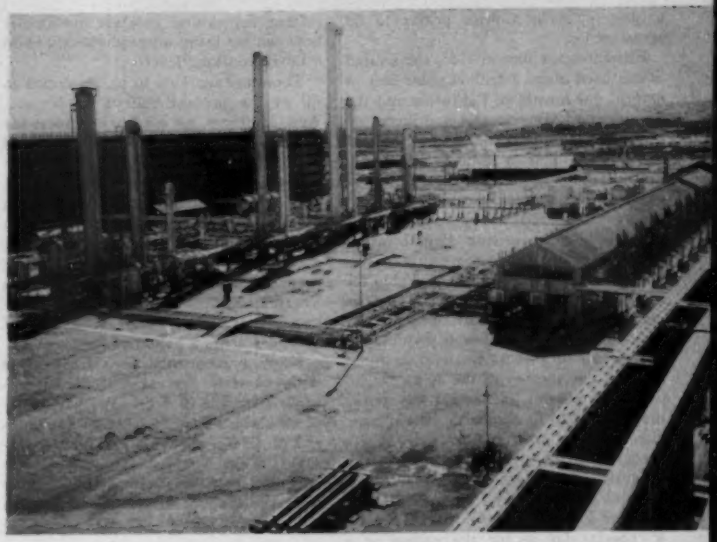
New dry gas field discoveries and the extensions of utility gas lines have kept the "gas manufacturing" use fairly constant. There has been a big switch in these special pressurized tank car deliveries from scarce butane to more abundant propane.

Industrial uses, such as railroad dining car cooking, cutting-torch gas, drying fruit, in ceramics work and so on, has gone up from 250 barrels daily in 1939 to about 800 last year.

Use in internal combustion engines has almost doubled in the period from 1939 to 1950, when about 2800 barrels made mileage on the road each day.

Figures for the chemical employment of LP-Gases are not readily available, because some companies use them in their own chemical manufacturing processes, but, it is substantial, perhaps several thousand barrels daily. Butadiene plants for synthetic rubber in Southern California require about 2500 barrels daily of the butanes.

The supply of butane is now largely devoted to the manufacture of gasoline, chemicals, butadiene and other products. Propane, more and more is becoming the LPG of general heating and fueling purposes.



Another View of One of California's Most Modern Gasoline Plants, the South Coles Levee Unit Cycling Installation.

These increases in demands, of course, have been accompanied by increases in production, which have called for substantial outlays in money, ingenuity and creativeness. The biggest production increase, of course, has been due to the greater recovery of light products encouraged—indeed compelled—by the new demands. Old processes have been improved and streamlined and new ones have come into being.

It is no exaggeration to say that there would not be oil field conservation as we know it without the natural gasoline industry.

The trend for many years has been away from the wasteful practices of the 20's. One most important step in this direction has been unitization. The natural gasoline operation fits perfectly into this plan. What unitization ultimately will accomplish can only be guessed at, but, for example, it has been estimated that operation of the 27-B Pool in the Buena Vista Hills field may result in the addition of 20 to 30 million barrels to our recoverable oil reserves.

So, the public benefits because great natural resources—crude oil and natural gas—are not depleted wastefully. The land owners get a greater ultimate return from royalties. The participating companies benefit by a more efficient use of equipment—natural gasoline plants included—and they can count on a larger eventual yield of crude.

Thus, even putting aside the market values of its own products, the natural gasoline business can justify itself, and far more, by its tremendous contributions to conservation.

It is not possible to place a monetary price on a thousand feet of gas forced back down into the earth to help natural forces produce more oil. But, there is a value, a price, for the natural gas that is sent to market. We have every reason to believe that this natural gas is completely undervalued. We are caught up by the price precedents set 25 years ago when the hunt was for demand and not for supply.

Undervalued Gas

On the basis of "original cost" formulas, natural gas is valued away below its actual present or replaceable worth and its relationship to competitive fuels. To quote from the gas consultant to the National Security Resources Board, "Natural gas is not only the most attractive fuel, but it is now generally the cheapest fuel in many areas for house heating and also for many commercial and industrial uses."

Nationally, on Btu content, the price of natural gas is usually lower than the equivalent in coal and frequently of oil. The *Wall Street Journal* estimated it costs in Chicago $119 a year to heat a six room house with gas, compared with $146 for coal, which is produced downstate in Illinois, while the gas has to be piped from the Southwest.

In coal's front yard, the Eastern seaboard, the future of natural gas is limited only by the steel needed for pipe lines. But, as natural gas adds to our standard of living, we should be willing

to pay for it at a price nearer to its actual value.

Estimates are that in 1935, the United States used about 1 trillion cubic feet of natural gas mostly in California and the Southwest. Last year this had increased something like 3½ times and natural gas was available in some 35 states.

Only about 30 percent of the natural gas sold is for home use and 9 percent goes to commercial shops. Industry gets the rest. Proper pricing should insure that industry not use too much of this fuel, to deplete the amount available for more valuable home use. From the objective and historic point of view, undervaluing a nonreplaceable natural resource can be just as wasteful as those burning gas torches of the 20's.

This discussion of natural gas prices may appear to be somewhat of a digression, but the protection of natural gas resources is of vital importance to the natural gasoline business.

Gains in LPG use on the Pacific Coast District 5, recently have not been quite so spectacular as for the nation as a whole.

The natural gasoline men of the Pacific Coast needn't worry that this slight difference reflects on them—indeed, taking a long backward look at their pioneering, we may find it an occasion for a pat on the back. Because of the earlier and more progressive advancement of LPG out here, we have covered a greater portion of the presently known sales market than have other sections of the U. S.

Problems of Success

Success, as always, creates its own new problems. The demands of rearmament have dipped closer and closer into butane supplies and its household use now is largely curtailed out here to provide for those users with older type low-pressure tanks, in accordance with the trend of the past several years. With propane performing even more efficiently with proper tanks, it is much more feasible to divert butane into the more critical uses.

Aviation gasoline requirements have bitten deeply into butane supplies and now with synthetic rubber going again, there will be an increased pressure on substitute propane supplies. We're extracting about all the butane we can from the wet gas, but we are far from fullest possible extraction of propane.

But, to approach complete extraction, more compressor plants and other expensive equipment will be required. Under present heavy seasonal demands, followed by off-season slacks, it is difficult to justify these additional facilities to meet requirements for just a couple of months yearly.

One of the most difficult problems besetting the natural gasoline industry is how can we bring all-year operations to a fairly constant level?

There are markets to be developed to fill in the present valleys of demand. And, somehow, we must try to meet the difficulties of storage. The expense of providing sufficient conventional type propane storage to accomplish a carry-over is prohibitive. As an example, a 42,000-gallon propane tank, costs about $30,000, or about 71 cents a gallon. By comparison a gasoline tank of the same capacity costs about $10,000, or 24 cents a gallon, and in actual practice larger gasoline storage is used at a cost of around 6 cents a gallon.

Many experiments have been made with varying success on the underground storage of LPG. We have a lot of such work to do in District 5; Standard of California has authorized a program to see what can be done to suit our particular Western needs, working with the kind of subsurface structures we have out here.

Further Uses Possible

As to the development of further uses in the off-seasons, one possibility is the further use of propane in heavy duty internal combustion engines. The main interest in propane, of course, centers in its lower per gallon cost as compared with gasoline or diesel fuel, although this price is partly offset by higher engine cost or conversion cost, and a considerably greater expenditure for customer storage. Nevertheless, propane-powered equipment is being used in bus systems in such places as Chicago, Kansas City, San Antonio and nearby Glendale.

While a general increase in the use of propane as a motor fuel might add to the peak season problem, further use in agricultural equipment and in the processing of farm products could well be a big step toward raising spring and summer consumption closer to a workable year-round level. Some of these off season uses already have developed in California in the use of LPG as fuel for cotton gins and for dehydration of many types of farm crops for bulk shipments. And, of course, there are such operations as kiln drying of lumber, manufacture of brick, ceramics and other industrial products.

As the military emergency has thrust new supply problems on the natural gasoline industry, it also has complicated the matter of expansion. The natural gasoline business has established a notable record of getting capacity operation from existing plants. Despite the great increase in production of natural gas liquids, the number of plants operated has decreased significantly. Between 1942 and 1950, production doubled, while the number of plants decreased by about one-fifth. The savings in steel and other materials, equipment and manpower have been of real value.

LP-Gases still are secondary to the intermediate uses in the refining processes. From your operations come natural gasoline, normal butane, iso-butane and propane, as separate products and as mixtures. The uses of these products change almost daily, as the refineries switch products to meet the stresses and strains of all types of demands.

Certainly, because of your efforts we are able to make better gasolines, not only for automotive use, but to give our military aircraft an edge over the enemy. Maybe it's that last drop of volatility or power that will make the difference between defeat and victory to some combat pilot. That last drop is what all the refineries always are trying to provide.

In my own company, it is our manufacturing department's constant job in the present emergency to make the best possible daily and seasonal use of the lighter products.

And that brings us to the relationship between the larger companies, the integrated operations, and the natural gasoline business. Long term planning is one of the most important contributions the refineries of the integrated companies, with their own marketing and distribution systems, can offer to the natural gasoline industry. Generally speaking, a company of the size of Standard Oil Company of California expects to know what it's going to be doing a month or six months from now.

So, in our acquisition of supplies from other companies in the natural gasoline industry we can help in a measure to even out the peaks and valleys of demands.

A Mutual Service

In this, you and we are able to perform a mutual service. And it has worked out to the advantage of the entire natural gasoline industry, small operators and large.

The men and companies who constitute all the various segments and operations of our oil industry, small, middle-sized and large, have done a fine competitive job, one that adds up to a strong, capable whole. They have been able to do the jobs asked of them; left alone, with a necessary minimum of regulation, they will continue to do them.

The problems that confront your association and the natural gasoline business are a vital part of the oil industry. They are problems that are a part of and inseparable from the industry as a whole. And they'll be solved.

NOTE

The above article is a slightly condensed version of a talk which Mr. Peterson prepared for delivery last month before the California Natural Gas Association in Los Angeles.

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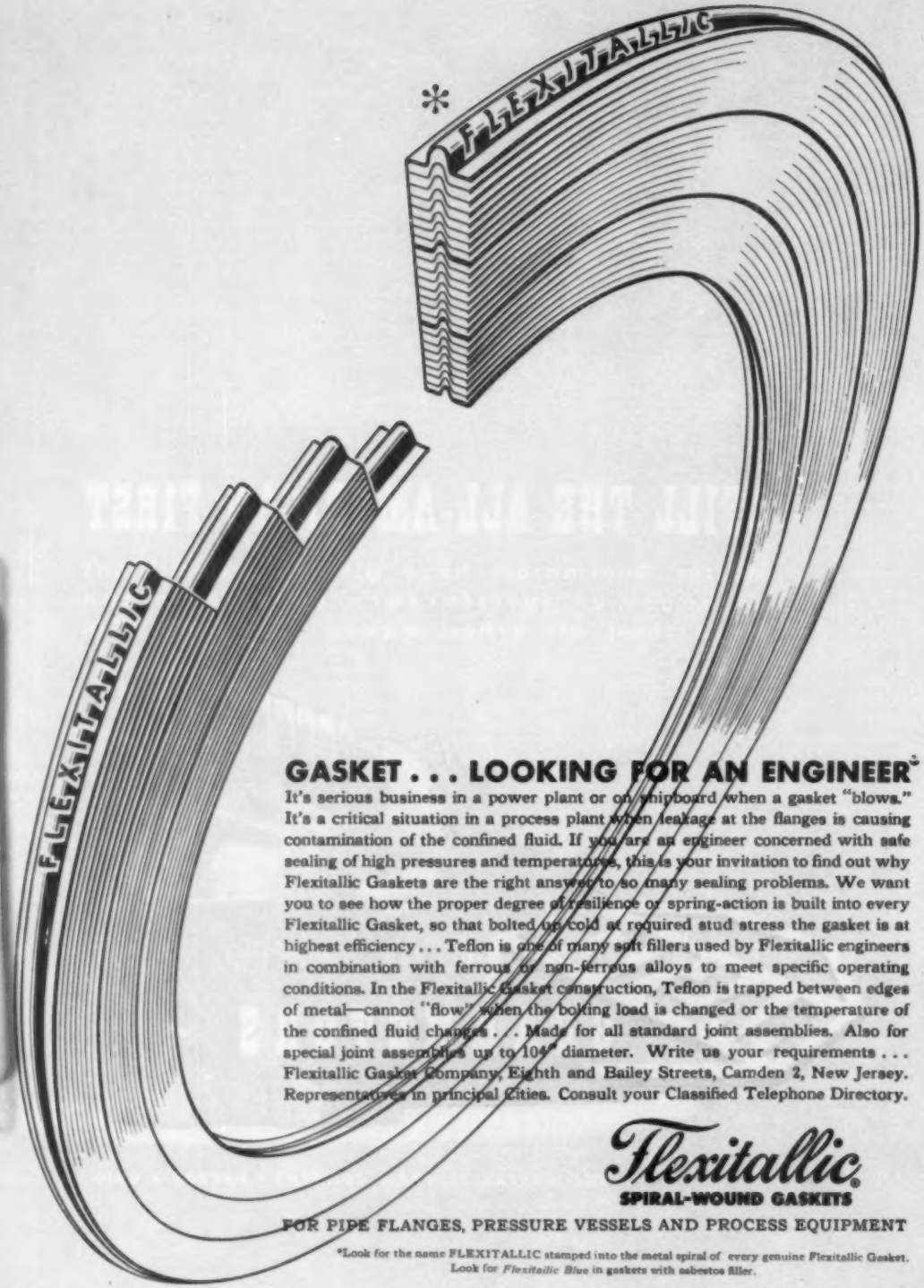

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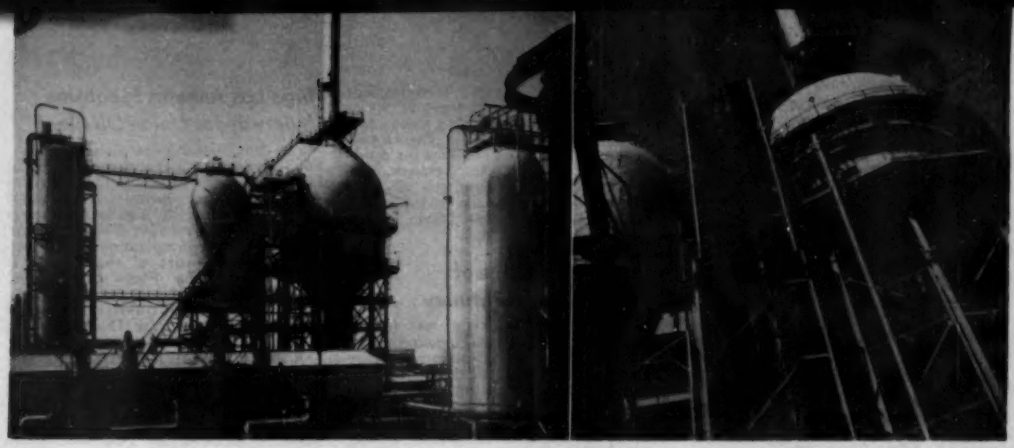

Twenty-two stories high, the cat cracker built at Gulf Oil Company's Port Arthur, Texas, installation, was finished in a year's time. The stack atop the regenerator, right, above, is 75 feet high. In the other photo, above, left, are shown the main units, left to right, as follows: the fractionator, the reactor, the regenerator, and the catalyst storage drum. The new equipment will have a thruput approximately 20 percent greater than that of any similar installation currently in operation. Particularly important among products to be manufactured are synthetic rubber ingredients which capacity will be nearly doubled by the new cat. (See news item below.)

News Notes on Refinery and Other Plant Construction

Petroleum Refiner's Quarterly "Box Score"

Tabulation Will Next Appear in the January Issue

French Production Raised To 50,000 Barrels by ECA

Expansion of French refining facilities to 50,000 barrels has been made possible by recent Economic Cooperation Administration loans.

A 6000 barrel-per-day catalytic cracking unit will be installed at the Donges refinery near Bordeaux. ECA has designated $400,000 for engineering fees and $170,000 for materials and equipment which must be procured from the U. S.

A loan of $250,000 has been made to the Shell-Berre refinery near Marseilles for installation of an 8000 barrel catalytic cracking unit. Of the total loan, $195,000 is earmarked for engineering fees and $55,000 for materials and equipment procurable in the U. S.

The new equipment will enable France to refine larger quantities of high grade motor fuels which will meet military specifications, and will reduce French requirements for benzol and tetraethyl lead, both in tight supply. Expansion and improvement of French production of jet fuels will also be effected.

Integrated Refinery at Kent Reported Progressing Rapidly

Work on Anglo-Iranian Oil Company's new integrated refinery on the Isle of Grain, Kent, England, is progressing rapidly. The schedule calls for two 40,000 barrels per day atmospheric distillation units to be operating at 60,000 barrels by early 1952. Full capacity of 80,000 barrels will be reached by 1953. Badger is doing both the engineering and contracting for this unit.

Two vacuum distillation units, with a capacity of 17,000 barrels apiece, will be completed respectively by mid 1953 and the Fall of 1953 by E. B. Badger.

A Fluid catalytic cracking unit of 10,000 barrels capacity, will be completed by the M. W. Kellog company about the same time the first vacuum unit is completed. A Furfural Extraction plant being built by Lummus, and designed for 2800 barrels capacity, will be completed to coincide with completion of the second vacuum distillation unit.

Kellogg is also installing the propane deasphalting unit. Foster Wheeler has been awarded the MEK Dewaxing project. Other units under construction include a 2400 barrel rerun unit; a 6000 barrel solutizer unit; four 8000 barrel copper chloride treating units; and an acid/soda washery.

When completed, the Kent refinery will ease off much of the loss felt by the nationalization of refining facilities at Abadan.

Sulfur Will Be Extracted At Waddell, Texas Gas Plant

Gulf Oil Corporation will build a sulfur recovery unit at its natural gasoline plant located at Waddell, Texas. The sulfur recovery unit, with a capacity of 20-tons-per-day, will recover hydrogen sulfide from waste gas. At present the plant produces 45,000 gallons of natural gasoline, 17,000 gallons butane, and 20,000 gallons of propane daily. Construction will begin in December and company officials say the plant will be in operation sometime next February.

McAllen Unit on Stream

Taylor Refining Company and Mayfair Minerals, Inc., formally opened the new cycling and absorption plant at McAllen, Texas, early this month.

Port Arthur Cat on Stream; Gulf Announces Sulfur Unit

The world's biggest fluid catalytic cracker to date, a 60,000 barrel per day unit at Port Arthur, Texas, was officially put on stream late last month when Charles R. Stevenson, a Gulf employe since its organization, turned the valve that sent the charge stock into the huge reactor tower. The over-all capacity of the plant is now 275,000 barrels of crude per day.

During brief ceremonies, Gulf Oil president, Sidney A. Swensrud, announced plans for a 60-ton-per-day sulfur recovery unit to be built by the Ralph M. Parsons Company, for operation by June, 1952. Construction which will "begin in the immediate future" will ultimately enable production of over 17,000 barrels of 100-plus octane gasoline.

Units for production of ethylene, and of iso-octyl alcohol are now under construction at Port Arthur.

PAD Approves Modernization Project for Bay at Denver

Addition of a 3500 barrel Fluid catalytic cracking unit, with tankage, and additional equipment for revamping and modernizing Bay Petroleum Company's Denver refinery, has been approved by the Petroleum Administration for Defense. Procon and Universal Oil Products will engineer and erect the units, all of which are scheduled for completion the latter part of 1952. The program will allow Bay to produce high octane gasolines and aviation gasoline components, while increasing crude throughput from 6000 to 11,000 barrels per day.

Danish Shipper Proposes New Refinery Near Copenhagen

A. P. Moeller, shipping firm of Copenhagen, has proposed construction of a thermal cracking refinery in that area and is at present negotiating with De Danske Spritfabriker, a Danish company holding the monopoly for alcohol production, for possible cooperation in the production of ethylene. If the 2000 barrel daily refinery is built it will be operated on heavy fuel oil, and will produce 3.5 million cubic feet of gas; 11,000

gallons LP gas; 300 barrels of gasoline; and 725 barrels of other products.

A pipe line to Copenhagen, to carry the gas from the plant to the city, is estimated to cost about $865,000.

Muskegon Plant Operating On Redwater Crude This Month

First lake shipment of Canadian crude from Alberta was delivered recently to the Old Dutch Refining Company, Muskegon, Mich., by tanker from the eastern terminus of the Interprovincial pipe line at Superior, Wis. Delivered cost of the crude compared favorably with the most favorable shipment of Mid-Continent crude, according to Harold M. McClure, president of Old Dutch. This month the Muskegon refinery increased its crude runs from 5000 to 7000 barrels per day. Next spring the plant will have a throughput of 12,500 barrels. A new compressor being installed on its platforming unit will increase production of high octane gasoline from 1500 to 2600 barrels per day.

Mercury Starts Expansion At Oklahoma City Refinery

Construction has been started at Mercury Oil Refining Company's Oklahoma City plant. The expansion program includes a new fluid catalytic cracking unit, gas concentration unit, polymerization unit, together with all necessary auxiliary equipment. Crude capacity will be increased from 3150 to 10,000 barrels daily.

Refinery Engineering Company of Tulsa is building the plant which will be completed before October 1952. The expansion is geared to production of high octane aviation gasoline and jet engine fuel.

Esso to Begin 30,000 Barrel Expansion at Baton Rouge

Esso Standard Oil Company will begin construction immediately on a $35 million expansion program at Baton Rouge, La., which will be completed late in 1953. The refinery's processing capacity will be raised from 240,000 to 270,000 barrels of crude per day. In addition, chemical expansion of butadiene, synthetic alcohols and benzene facilities is planned. Refining facilities will include a 1,000 barrel per day crude distillation unit, expansion of fluid catalytic cracking facilities to 31,000 barrels per day, and aviation gasoline facilities.

Caltex Seeking Australian Refinery Site for New Plant

Caltex Oil (Australia) Pty., an affiliate of California Texas Oil Company, is planning a 22,000 barrel per day refinery in Australia which it is estimated will cost $56 million. The site for the refinery has not as yet been selected, and the date of construction is indefinite.

Facilities Announced for Esso's Baton Rouge Plant

The $35 million expansion by Esso Standard at its Baton Rouge plant will include a two-stage pipe still, expansion of fluid catalytic cracking facilities, additional equipment for processing petroleum gases for chemical base stocks and aviation components, and expanded blending and shipping facilities for products. Units for producing benzene, and more butadiene and synthetic alcohols are also included. Capacity for crude processing will be increased from 240,000 to 270,000 barrels per day.

Haifa Seeks Source of Crude for Large Refinery

It may be that England will find it expedient to reopen the Haifa refineries which could be put on stream at very short notice. At present, the staff is operating one single refining unit, but capacity could be brought to 80,000 barrels daily, or 170,000 barrels when the sister refinery at Haifa is completed. Crude, no longer available from Iraq since the pipeline was sealed last May, must be transported from South America to Haifa, and then transported to Europe as a refined product. This double transportation has been thought too costly in British circles to date.

AIOC and Australian Firm Discuss Major Expansion

Further word from Australia discloses that the Anglo-Iranian Oil Company in conjunction with the government-owned Commonwealth Oil Refineries is planning to build units to process 55,000 to 85,000 barrels per stream day of crude. The additional capacity which will cost between $67.2 to $89.6 million, may possibly be built as an extension to Commonwealth's refinery at Victoria. AIOC technicians have been in Australia consulting with officials at the Victoria refinery.

Sulfur Extraction Added To Texas Natural Gas Plant

A new sulfur extraction unit to be added to the Slaughter Gasoline Plant at Sundown, Texas, will be operated by Stanolind Oil & Gas Company in behalf of eight participating companies. Fluor Corporation will build the unit, which is designed to recover 40 tons of sulfur daily.

Kellogg Awarded Contract For Iraq Government Plant

A government owned oil refinery to be located near Baghdad, Iraq, will be built by The M. W. Kellogg Company. Designed for 24,000 barrels-per-day capacity, the plant will cost about $25.2 million. Crude will be delivered by twelve-inch pipelines that extend some 135 miles from the Baiji fields.

Midland Gas Plant Started

Preliminary work on Phillips Petroleum Company's Spraberry natural gasoline plant at Midland, Texas, is underway. The plant will ultimately process in excess of 100 million cubic feet of gas per day and will serve the Tex Harvey, Germania, and Driver areas in Midland and Glasscock counties.

See Page 168 for Brazil's new refining plans.

Huge Los Angeles Expansion Underway for Union Oil Plant

The $26,700,000 expansion and addition program under construction at Union Oil Company of California's Los Angeles refinery includes two 20,000 barrel-per-day crude distillation towers with a common vacuum distillation unit. Scheduled to be in operation by November, 1952, this part of the project is being handled by Fluor Corporation. Flour is also in charge of revisions to the tankage and oil transfer system, as well as revisions to the Thermal cracking unit.

A 28,500 barrel Fluid catalytic cracking unit is being built by Arthur G. McKee Company, licensed by Universal Oil Products Company, and will be completed in June, 1952. McKee will also make revisions to the TCC unit, which is licensed by Houdry.

Engineering for a hydrogen sulfide recovery system is being done by Girdler Corporation, but the construction contract has not been awarded as yet. A 200,000 pound boiler and revisions to the steam system is being handled by C. C. Moore & Company, while Bechtel Corporation makes revisions to the water system.

A 15,000 barrel acid treater and rerun column has been designed by C. F. Braun Company and will be constructed by them prior to August, 1952. Additions and revisions to the Unisol plant, scheduled for completion in June, 1952, are being handled in both the engineering and construction phase by Ralph M. Parsons Company.

Expanded Operations Put On Stream at Detroit Refinery

Construction has been completed at the Aurora Gasoline Company refinery at Detroit. The operation of the enlarged crude oil topping unit brought refinery capacity to 30,000 barrels-per-day. This unit was built by the Aurora staff. Universal Oil Products Company engineered and licensed the Catalytic reforming unit, capacity 6000 barrels daily, which was completed last month.

Natural Gasoline Plant Begun

This month Standard Oil Company of California began construction of a natural gasoline plant in the Elk Hills Naval Petroleum Reserve, San Joaquin. Standard-California will operate the plant for the Navy. It will produce from 50,000 to 100,000 Mcf. daily and will cost about $5 million. Parsons-Macco Company of Los Angeles is the contractor. A 100 mile gathering system was started last month.

Burma Would Nationalize

The government of Burma is negotiating with the Burma Oil Company for a joint exploiting company in which it would own one-third of the share capital. Prime Minister Thakin Nu recently admitted that his government would like to nationalize Burma's oil industry.

Ground Broken for Expansion

Groung will be broker soon at Pure Oil Company's Smiths Bluff refinery for early construction of a $12 million expansion program which was announced last May when the Defense Administration cited the project for 75 percent rapid tax amortization on over $11 mil-

225,000 bbls/day

These three crude distillation units, in operation in a Gulf Coast refinery with a combined capacity of 225,000 barrels per day were . . . . . .

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This unit, the latest of the three shown on the other side of this insert, embodies all the improvements gained from the design and operation of the other two—another example of REFINER-FOSTER WHEELER cooperation.
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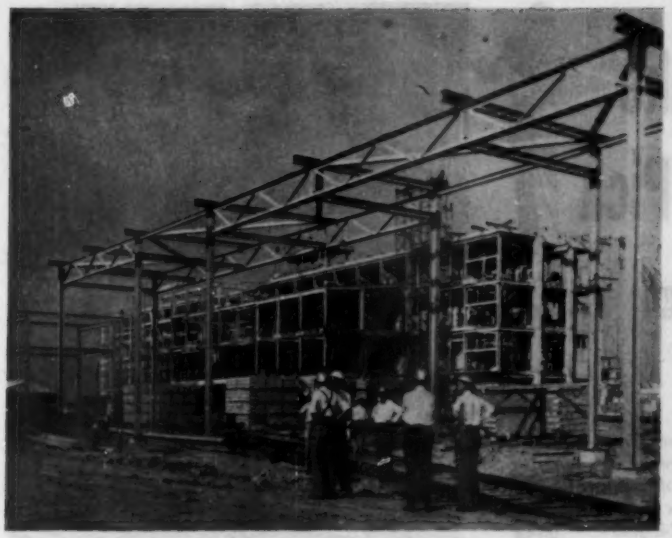

PROGRESS ON NEW ETHYL PLANT: A $50 million plant for manufacturing antiknock compounds and other chemicals is being built on the Houston Ship Channel by Ethyl Corporation. This photo shows the central tetraethyl lead manufacturing building as it was being inspected last month by the company's directors and other officials from New York, Baton Rouge and Detroit. The new Houston plant, scheduled for completion in the spring of 1952, will increase Ethyl's antiknock compound capacity by about one-third.

lion. The M. W. Kellog will handle the four main units but various contractors have been awarded contracts for related facilities.

A Fluid catalytic cracking unit, with a daily capacity in excess of 26,000 barrels, with catalytic polymerization facilities, an expanded alkylation production and feed preparation facilities with a vacuum flash capacity of 20,000 barrels will be the major units of construction. Actual construction will get underway early next year.

Continental's New Lab at Ponca City Nears Completion

Continental Oil Company's new three-story air-conditioned laboratory building under construction in Ponca City, Okla., will be completed late this Fall, according to Wigton-Abbott Corporation of Plainfield, N. J., designers and builders. Featuring an unusual arrangement of completely concealed air-conditioning duct work and laboratory utility lines in common chases, the new lab is joined to an existing administration building by a second structure containing a library and lecture hall.

Gulf to Add 63,000 Barrel Cat Cracker at Philadelphia

Gulf Oil Corporation has announced plans for a $200 million expansion program, with major units being built at its Philadelphia refinery. Gulf's "world's largest" cat cracker at Port Arthur, Texas, will be topped by the 63,000 barrel cat to be installed at Philadelphia. In addition a 125,000 barrel atmospheric and vacuum crude-oil topping unit will be built. This expansion will boost the military supply of high octane gasoline by 1000 barrels daily.

Shell Announces New Sulfur Recovery at Houston Plant

A sulfur recovery unit is the newest addition announced for the Shell Chemical Company's plant at Houston. The new operation will utilize waste refinery gases, and the output will be sold for conversion to sulfuric acid. The sulfur recovery unit will be built by Ralph M. Parsons Company of Los Angeles, and will be in operation by mid 1952. It is estimated that 13,000 tons of sulfur will be recovered annually.

Although sulfur recovery is not generally a part of petroleum refining operations, Shell has entered the field because the rate of consumption has outstripped domestic production of sulfur in the U. S. by 500,000 tons. The unit will also help eliminate the problem of atmospheric pollution in the industrialized Houston area.

Snyder Gas Plant Formally Dedicated to Conservation

The Snyder, Texas, gasoline plant which went on stream in June, was formally dedicated to natural gas conservation recently. The Snyder plant already produces the largest amount of products of any similar plant in operation, exclusive of those which also recycle natural gas. It is operated by Sunray for some 30 participating companies.

Tuscola, Ill., Petro-Chem Construction Announced

National Petro-Chemicals Corporation has disclosed plans for the erection of a $32 million plant at Tuscolo, Ill. Panhandle Eastern Pipe Line Company will supply natural gas requirements for a 20-year period, with deliveries scheduled to start late in 1952. National Distillers Products Corporation will supply surplus chlorine to produce ethane, propane and natural gasoline. The ethane will be further processed while the propane and gaoline will be sold to Phillips Petroleum Corporation under a long-term contract.

The petro-chemical company was formed earlier this year and is owned by National Distillers, 60 percent, and Panhandle Eastern Pipe Line, 40 percent.

Standard Indiana Expands Benzene from Oil Production

Benzene produced from petroleum is on commercial shipment from Standard (Indiana) Oil Company's benzene plant at Whiting, Ind. Plans are already underway to expand the new plant. At present the Whiting unit produces about 11 million gallons of benzene annually, and expansion is designed to provide an additional capacity of 6 million gallons.

Until recently benzene was manufactured as a by-product of coke production, but the insufficient supply led Standard (Indiana) to start manufacture of benzene from petroleum. Most of the production will be sold to the chemical industry.

Two Standard subsidiaries, Pan American Petroleum & Tarnsport Company, Texas City, and Indoil Chemical Company went into production of benzene last year.

Foster Wheeler Awarded Columbian Expansion Job

Foster Wheeler Corporation has been contracted by Empresa Columbiana de Petroleos to install various processing units in the 13,000 barrel expansion announced last month. The units include a 38,000 barrel topping unit, a 15,000 barrel Fluid catalytic cracking unit, a 16,500 barrel vis breaker, a 1200 barrel alkylation unit, and other related facilities. Construction is scheduled for completion in 1953.

Permolio's Milan Plant Gets Expanded Lube Production

Permolio S.p.A., the Italian refining firm of Raffinerie Italiane Olii Minerali, recently advised that the project cited for Milan includes additional units for production of 15,000 tons of lubricating oil a year. Standard-Texaco will license a Furfural solvent refining unit, a propane deasphalt unit and an M.E.K. dewaxing unit. In the planning stage, contracts for the three units have been assigned to Foster Wheeler. The probable completion date for the above units, as well as for the Perco Reforming unit of 350 barrels daily previously reported, is sometime in 1952. The cost of the entire project is quoted at $2,104,000.

New Edmonton Refinery Is Third Major Operating There

McColl Frontenac Oil Company's plant at Edmonton, Alberta, recently put on stream, is the third major refinery in operation in the industrial area just east of that city. The $10 million refinery can handle 5500 barrels of crude daily.

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The pictures here show only a few of the many purposes served by Worthington Centrifugals. Whether your problem is high temperatures . . . volatile liquids . . . abrasives . . . acids . . . or any of the host of others that harass refineries—the Worthington line includes the one best pump for the job.

Further assurance you enjoy when you standardize on Worthington: you know that Worthington, making the broadest line of pumps, will recommend the best type for each job—you know you'll benefit from *engineering* that's the finest in the business—and you know you can depend on *service* that does its best to keep you in peak production.

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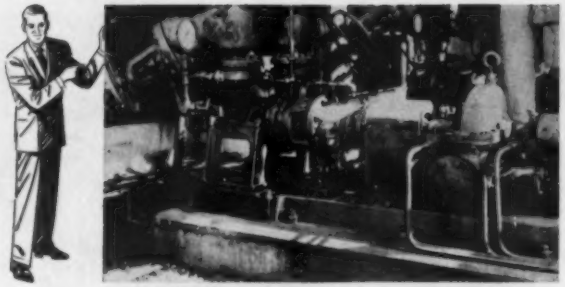
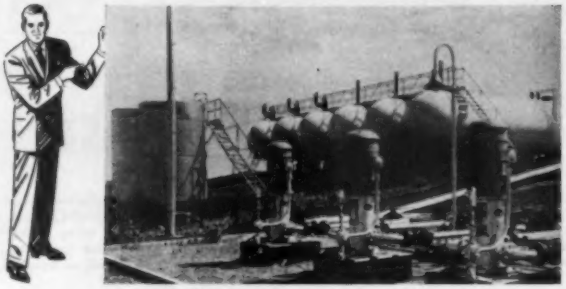
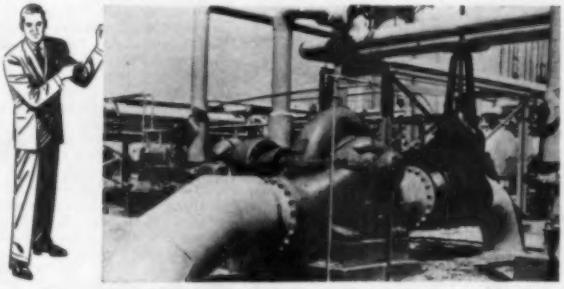


WORTHINGTON HR CENTRIFUGAL, shown at Sun Oil Co., Marcus Hook, Pa., is typical of pumps used in distillation, cracking and treating petroleum products.



WORTHINGTON QER VERTICAL centrifugal process pump, shown at Magnolia Petroleum Company, Chitwood, Oklahoma, is used to transfer propane, butane and LPG.



WORTHINGTON LA CENTRIFUGAL, turbine-driven, shown at Carthage Corporation plant, Carthage, Texas, is typical of cooling tower and general service pumps.

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Types HR and HB Capacities to 1800 gpm. Heads to 900 ft. Temperatures from far below zero to 800 F. Pressures from high vacuum to 750 lb. gauge.

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Type CNB For loading or transfer service. Capacities to 1500 gpm. Heads to 500 ft.

Type HN Available in 12 sizes. Capacities to 700 gpm. Heads to 650 ft. Maximum temperatures 300 F.

Will Refineries Prove Vital A-Bomb Targets?

THE AMERICAN refining industry presents to any potential enemy "unit targets" of considerable importance to both national life and the successful conduct of war. In event of foreign attack with atomic weapons, the refining industry would probably find itself a primary target of aggression. The accompanying article is a digest of a paper by Commander Robert C. Wing, U. S. N., and published by the U. S. Naval Institute organ, "Proceedings."

IT HAS been fearfully conceded by the American people that the atomic bomb is a weapon against which there is no defense, that the nation possessing sufficient atomic weapons will swiftly and surely win any war. What exactly will be the position of the petroleum industry, and the refining segment in particular, in case of such an atomic attack?

Because the atomic bomb is such an expensive weapon it cannot be used in concentrated bombings like the conventional World War II bombs. It must be reserved for primary and choice strategic targets where industry and population are concentrated. Even then, says Commander Robert C. Wing in the U. S. Naval Institute organ "Proceedings" the amount of destruction that an atomic bomb can accomplish depends on the area selected, the number of bombs available for the operation, and the enemy's ability to place acculately. Severe blasts alone damaged heavy steel buildings at Nagasaki over an area of 1.8 miles in diameter, an area sufficient to cover the major production units of most refineries. A direct atomic hit can destroy heavy steel building completely within a four square-mile area. This then is the bomb's potential to disrupt petroleum operations in the U. S.

Production operations, while concentrated within each field, are spread out over literally hundreds of oil and gas areas. Commander Wing dismissed atomic attack on production activity as still outside economic feasibility.

In contrast, the trend within the refining industry to expand existing facilities has developed to a situation wherein three-fourths of our refining industry is owned and operated by 18 major companies. During World War II, these 18 companies accounted for 80 percent of 100-octane gasoline plant construction, most of it expansion to existing facilities. This trend is easily explained in terms of economic expediency. Expansion through integration with existing facilities results in operating economies, requires less steel, manpower, utilities and housing. However, this concentration, together with the refinery's inevitable location near other industrial concentration, makes it a high priority target objective. In addition, reports Commander Wing, "the refineries are so logistically important that their destruction would be directly and immediately reflected on the field of battle. Destiny has it that the refining industry must face attack by atomic bomb, if war should come."

The result is that principal installations such as cracking units, distillation facilities, and alkylation plants would be exposed to heavy and concentrated damage from the atomic bomb, whose area of effectiveness is probably 5000 to 15,000 times the area of effectiveness of the conventional bomb. Light steel characteristics of tank farm construction is such that the area of structural damage to them would be at least two or three times that of refinery process units. The development of underground storage facilities should provide some surcease from anxiety in this instance.

During bombing raids successful damage control is an absolute necessity for the containment of cumulative results of even minor destruction. This program was successfully activated in World War II, when an interim period between attacks of the series necessary for complete demolition, gave the damage control program time to work. There will be no opportunity for damage control operations during successful atomic attacks because the atomic bomb is apparently so extremely destructive that one attack will virtually annihilate the target area.

What is the forseeable threat to our harbors? Harbors and tanker transportation of petroleum would assume increasing importance in the event of war. Statistics for 1945 show approximately 1 million short tons of crude and finished products were moved daily by tanker in and out of our ocean terminals in domestic and foreign trade. The 500,000 short tons moved today reflects a certain market recession and postwar changes in the export-import pattern. However in event of emergency this slack would disappear and the actual movements would approximate or surpass the 1945 movements.

The Secretary of Defense has acknowledged before an open hearing of the Armed Services Committee of Congress that in the event of war the nation must have at least 2 million barrels per day more production than the continental U. S. is capable of yielding. If access to foreign sources can be maintained during a time of war, the U. S. war machine will want to take from those areas 2 million barrels per day which are not available in this country. Add this import requirement to the 7 million barrels moved daily in 1945 by tanker in and out of ocean terminals, and it can be readily understood how vital harbor facilities are to the operation of the American petroleum industry.

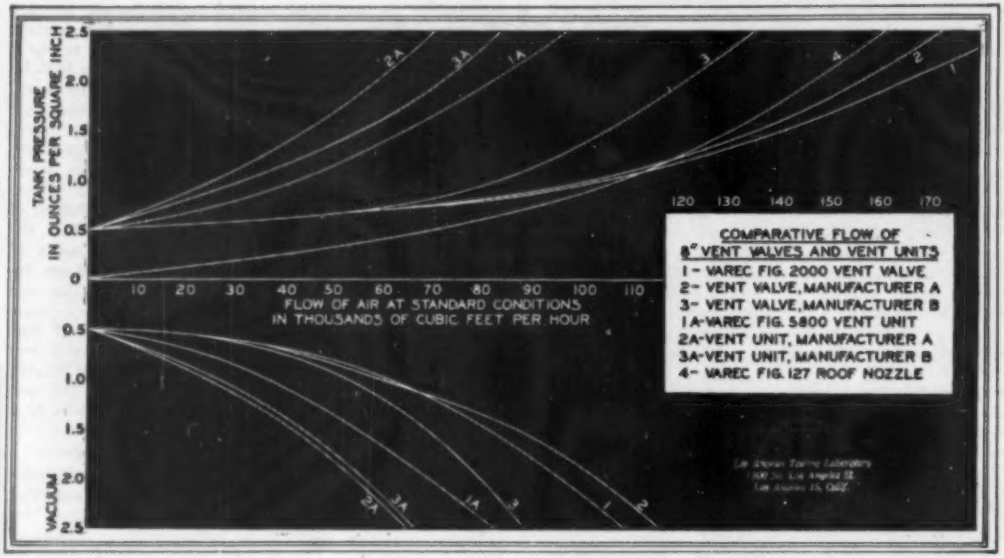
How effective will the atom bomb prove against U. S. harbors? Most American ports are notable because of their tremendous size. For example, the port of New York has 770 miles of waterfront, of which only 350 are developed. When we consider that one atomic bomb can destroy steel frame buildings only within an area of four square miles, it is evident that a tremendous number would be needed against this one port alone. The cost involved to destroy a port such as New York would be fantastic.

Meeting Port Problem

The U. S. has approximately 62 major ports capable of handling an estimated 18 million long tons per month of dry cargo under normal working conditions. This capacity could be increased to an estimated 25 million long tons per month by the more effective use of lighterage and the more intensive use of alongside facilities to reduce the turnabout time of vessels. At present, less than 50 percent of U. S. potential port capacity is being used. The unused and expandable capacities represent a cushion that can be used to absorb much of the effect caused by an atomic weapon attack. Use of alternate ports, and in an extremity, use of tankers anchored offshore connected with floating lines for loading or cargo discharge, can be used to keep harbor facilities open.

In conclusion, Commander Wing points out, concentrated nature of the refining industry has caused it to be the most highly vulnerable segment of the petroleum industry as concerns atomic warfare, and certain to be classified as a target objective of high priority. American harbors, because of their great size and number, in addition to emergency measures, will not be rendered helpless even during atomic warfare. Oil production operations, concentrated within themselves but scattered and many in number, will be unlikely targets for the costly atom bomb.

CUT YOUR TANK VENTING costs


TANK PRESSURE IN OUNCES PER SQUARE INCH
VACUUM
2.5
2.0
1.5
1.0
0.5
0
10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170
FLOW OF AIR AT STANDARD CONDITIONS IN THOUSANDS OF CUBIC FEET PER HOUR
2A 3A 1A 3 4 2 1
COMPARATIVE FLOW OF 8" VENT VALVES AND VENT UNITS
1 - VAREC FIG. 2000 VENT VALVE
2 - VENT VALVE, MANUFACTURER A
3 - VENT VALVE, MANUFACTURER B
1A-VAREC FIG. 5800 VENT UNIT
2A-VENT UNIT, MANUFACTURER A
3A-VENT UNIT, MANUFACTURER B
4 - VAREC FIG. 127 ROOF NOZZLE

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"VAREC" Figure No. 5800A Conservation Vent Unit—consists of Figure No. 2000A Vent Valve and Figure No. 50 Flame Arrester.

Compare vent valves on a basis of flow and you may find that a smaller valve or even a single valve instead of two has sufficient capacity to do your job. Even if the same size is required, *the valve with most flow capacity gives you the greatest tank protection.*

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Flow through all vent units is governed by the flame arresters. "VAREC" Figure No. 50 Flame Arresters have largest net free area and permit highest flow with required safety against flame propagation. They are listed by Underwriters' Laboratories and approved by Associated Factory Mutuals Laboratories and other governing agencies.

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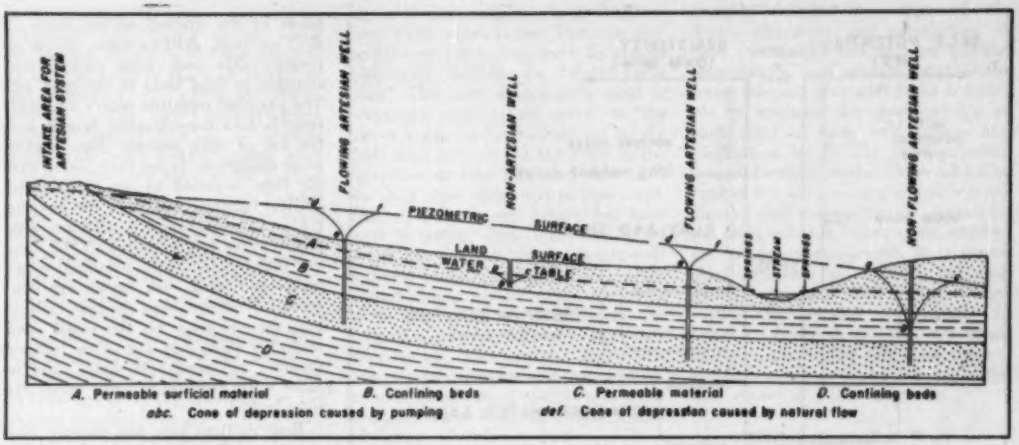

Figure 1. Diagram Illustrating Artesian and Non-Artesian Conditions (from Louisiana Geological Survey Bulletin 20).

PETROLEUM
REFINER
NOVEMBER, 1951

Ground Water with Reference to the Oil Industry

JOHN C. MAHER
Geologist, Fuels Branch, Geologic Division,
U. S. Geological Survey, Tulsa

THE OIL industry is one of the largest consumers of water. The production of one barrel of crude oil requires an average of 180 gallons of water, and the refining of one barrel of petroleum products consumes an average of 770 gallons of water. Thus one gallon of gasoline may represent the consumption of about 22 gallons of water, and a single refinery may require 10 to 30 million gallons of water a day.

Whenever possible, these demands are met with water from wells, or ground water, rather than water from streams and lakes, or surface water, because of the clarity, the relatively uniform low temperature, the constant chemical character, and the natural storage of ground water, all of which minimize the capital investment required and reduce the operating costs. Because of the economic importance of ground water to the oil industry and the probable construction and expansion of refineries and associated chemical plants in the next year to meet the demands of our defense program, this article has been prepared to outline briefly the general methods used in the exploration of large industrial ground-water supplies. The general methods of well construction, development, and testing are outlined in the article. Publication has been authorized by the director of the U. S. Geological Survey.

THE water that falls on the surface of the earth as rain either flows off directly through surface streams, evaporates, or soaks into the ground. Some of that which soaks into the ground is returned to the atmosphere by transpiration from plants or by evaporation from the soil, but part percolates downward through the surficial materials until it reaches a zone in which the rock is completely saturated. There it is stored temporarily, moving slowly to natural outlets. The water in this saturated zone is the body of ground water which supplies springs and wells. The upper surface of this body of ground water is known as the water table.

The water table is a gently undulating surface. It is generally higher under high land, where the supply of ground water is replenished by the downward percolation of rain water, than in the lowlands where the ground water is discharged by springs, evaporation, and the transpiration of plants (see Figure 1). The movement of the ground water is always in the direction in which the water table slopes. This is generally from high ground toward the streams and lakes where it emerges at the surface.

In some regions, inclined permeable beds are underlain and overlain by relatively impermeable beds. Water falling as rain upon the outcrop or intake area of these permeable formation percolates downward and then laterally until it becomes confined between the inclined impermeable beds. Further percolation is restricted to lateral movement in the conduit and the water is under what is termed artesian pressure. The water in a well penetrating this reservoir at any locality that is structurally lower than the water table in the intake area will rise in the casing, (see Figure 1). Such a well may be called an artesian well whether or not the pressure is sufficient to cause it to overflow at the surface. Losses of pressure due to friction and seepage cause the pressure head or static level in artesian wells to di-

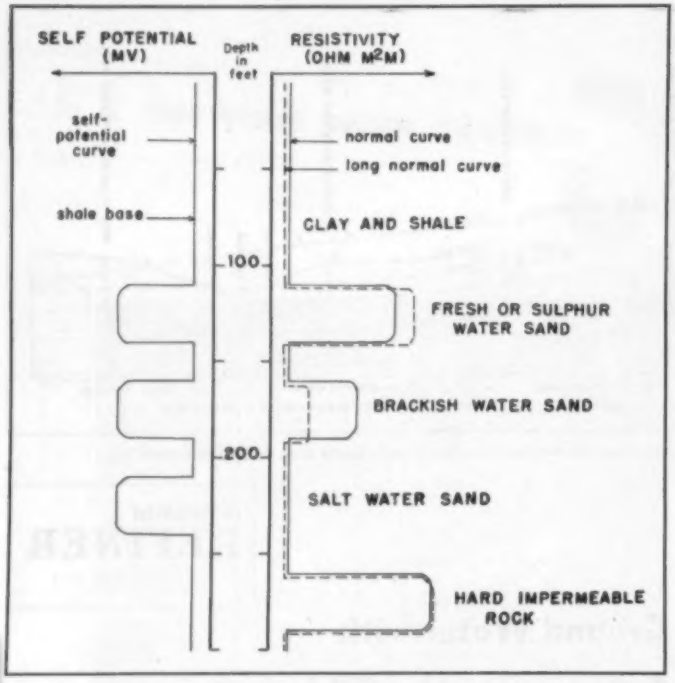

Figure 2. Diagram Illustrating Interpretation of Electric Log of Water Well.

minish with distance from the intake area. This results in a natural pressure gradient or piezometric (Greek—"pressure-measuring") surface. Thus the piezometric surface of an artesian formation represents the height to which water will rise in tightly cased wells (see Figure 1). Most of the deep water wells supplying the oil industry are nonflowing artesian wells.

Test-Drilling and Sampling Methods

There are several methods of test drilling including jetting, coring, and drilling with cable or rotary tools. Generally jetting can be used only in very soft formations, coring can be used only in tightly consolidated formations, and cable tools are economical only where hard limestone, dolomite, and chert beds predominate. Most modern test drilling is done by rotary methods.

Specifications for test drilling by rotary methods should always include a clause providing for the proper collection of samples at 10-foot intervals except in water sands where samples should be taken at 5-foot intervals. It should be noted, however, that samples cannot always be obtained when drilling in "gumbo" or clay. Whenever a water sand is penetrated, drilling should be suspended for 10 to 30 minutes (the length of time depending upon the depth of the hole and volume output of the mud pump) while the mud is circulated to clean out the hole. When it is judged that all or most of the drill cuttings have been removed, the ditch returning mud to the pits should be cleaned out. Drilling may then be resumed for 5 feet. Again drilling may be stopped and the mud circulated for 10 to 30 minutes before collecting sample portions at 5-foot intervals along the ditch. The combined sand sample portions may then be washed free of drilling mud, placed in clean cloth sacks or quart-size cardboard containers, labeled, and retained for mechanical analysis for determining proper screen size. The mechanical analysis of these sand samples are useful for comparative purposes in selecting the sand to screen, even though the rotary method of drilling does not permit accurate sampling of unconsolidated materials.

Drillers Logs

A record of the formations penetrated in each test hole should be made by the drillers on the basis of drill cuttings, drilling time, action of rotary table and mud pump, and changes in fluid level in the mud pit. The personal equation enters into such records to a considerable degree, and the use of such records does require some discretion. It has been found that the logs recorded by an experienced driller, familiar with both the drilling rig and underground conditions, generally agree fairly well with the electric logs insofar as the principal water sands and hard rock layers are concerned. However, even the best drillers logs do not show all the small sand and clay beds that are often lumped together as "sand and shale," and in some wells even thick water sands are over-looked.

Both drillers logs and electric logs are desirable in water wells. The drillers log generally supplies accurate information, permitting the tentative correlation of water sands as the well progresses; the electric log made after completing the hole offers mechanically recorded evidence of the formations penetrated and gives considerable information on the permeability of the water sands and the quality of the water therein. The mechanically recorded drilling time logs, developed in the last few years for oil wells, also are useful.

Electric Logs

After each test hole has been drilled to the desired depth, it should be conditioned by circulating drilling mud for a period of 1 to 3 hours to insure uniformity of mud in all parts of the hole and to build up a heavy mud cake in the water sands to prevent caving upon withdrawal of the drilling tools. As soon as possible after the removal of the drilling tools an electric log of the formations penetrated should be made by one of the several commercial firms specializing in such services for oil wells.

An electric log is a graphic record on film strip of the self-potential and apparent resistivity of the formations penetrated by the drilled hole. The self-potential is recorded as the difference in electric potential between formations in the hole and a point on the land surface. This is shown as a continuous line, or curve, on the left-hand side of the log (see Figure 2). The apparent resistivity of the formations is determined by sending a current of electricity into the wall of the hole and measuring the rate of potential drop. This is shown as a continuous line, or curve, on the right-hand side of the log (solid line, Figure 2). This curve, known as the normal curve, is made with closely spaced electrodes.

It determines formation boundaries accurately but, owing to the small penetration of the curve, does not give an accurate idea of the fluid content of the formation. An additional curve, known as the long normal curve (dashed line, Figure 2, is usually made with more widely spaced electrodes at the same time as the normal curve is recorded. The long normal curve is not accurate for formation boundaries, but owing to its deeper of the fluid content. In some areas still penetration it provides a better idea another curve is recorded for even deeper penetration.

The theory of electric logs and their interpretation is beyond the scope of this article, but such information can be obtained from the literature or the electric logging companies. In general, however, it may be said that an electric log is interpreted by examining the form of the self-potential and resismud and the temperature range in the hole. There is no handy rule of thumb resistivity and viscosity of the drilling tivity curves with consideration of the for this interpretation, but the following is generally true in fresh-water wells (see Figure 2):

Fresh Water Interpretation

Shales and clays are indicated when both the self-potential and resistivity are low. The almost straight self-potential curve recorded in shale or clay is sometimes referred to as the "shale base;" that is, any deviation from this line indicates a change in the porosity of the formation. This shale base may shift abruptly between marine and continental sediments but remains relatively constant in sediments of one origin.

Fresh-water sands are indicated by sharp deflections of the resistivity curves to the right and more moderate deflections of the self-potential curve to either the left or right away from the shale base.

Salt-water sands are indicated by little or no deflection of the resistivity curves to the right and moderate to pronounced deflection of the self-potential curve to the left. Brackish water in a sand is often shown by the long normal resistivity curve recording less resistivity than the normal curve. The more resistive fresh-water drilling mud in the sand adjacent to the drilled hole contrasts with the less resistive natural water in the sand.

Hard, dense rocks are indicated by a sharp deflection to the right of the resistivity curves and little or no deflection of the self-potential curve from the shale base.

On the basis of information obtained from the electric log, drillers log, and sand samples, the most promising water sands in each test hole may be selected for further tests, known by water-well drillers as "drill-stem tests." This term as generally used in petroleum exploration refers to the use of a patented testing device on the drill stem that allows the fluid in the formation to flow into and partly fill the drill stem under natural pressure. This same device can be and has been used in testing some water wells but is not in common use by water-well drillers. Instead, many drillers place a short screen section on the drill stem in the sand to be tested and pump the formational water through the drill stem by air. This permits the collection of water samples and the measurement of temperature, static water level, pumping water level, and yield with a minimum of delay.

The drill-stem tests are made by setting ten feet of screen on the drill stem in the selected sand with an improvised canvas or burlap packer above the sand. A commercially manufactured packer for this type of work may be more satisfactory if available. After placing the screen and packer, the mud cake on the sand to be tested is broken down by alternately washing by forcing water into the well and pumping the well by air. In order to retain the mud seal on the upper sands the mud column above the packer should be disturbed as little as possible. During the pumping of water from the formation the level of the mud in the hole outside the drill stem is carefully observed to detect any failure of the packer to hold.

After testing the lowermost sand first, the bit is run in the hole and heavy mud is circulated until the sand is sealed. Then the screen is placed opposite the next lowest sand, and the process is repeated until all the selected sands are tested.

The data obtained from such tests must necessarily be used with discretion. The measurements of yield and pumping level in the test hole give little indication of the probable performance of the final supply well, but they help to show the relative water-bearing properties of the different sands. The water samples (for preliminary chemical analysis only), the temperature recordings, and the static water-level measurements are usually satisfactory and worth while.

Benefits of Ground-Water Exploration

The benefits of an adequate exploration program prior to any large development of ground water are self-evident. Adequate test drilling will provide definite knowledge of the depth, character and correlation of each water sand and data on quality, temperature, and artesian head of the water therein. This will make it possible to evaluate the potentialities of each sand in each well before any contract is let or any great expenditure of funds is made. These data also enable the well owner, consulting engineer, and contractor to determine the most suitable construction method and pumping equipment. It is generally advisable to conduct the test-drilling program and actual water-supply development separately in order to establish a basis for exact specifications which save time, money, and misunderstandings for both the well owner and the contractor.

Hydraulics of a Well

The effects of pumping a well are somewhat similar in both artesian and nonartesian formations although the effects are transmitted more rapidly in the artesian system where pressure is involved. When an artesian well is pumped, the head of the water in the well immediately drops when the pump starts, and at the same time the pressure head in the formation around the well drops. The decline in head is greatest in the well and decreases with distance from the well (see Figure 3). The piezometric surface thus becomes steeply inclined immediately outside the well, but with increasing distance from the well the gradient gradually becomes more gentle until, within a few hundred or a thousand feet, it merges with the natural piezometric surface. This inverted bell-shaped depression in a piezometric surface is called the *cone of depression*.

When the pumping of the well ceases, the pressure head increases until the water recovers to or almost to its original or "static" level. This recovery at first is very rapid, then slower as the original level is approached. The time required to reach essential equilibrium after the discharge has ceased is approximately the same as the time required to reach essential equilibrium during discharge.

The difference between the static level of the water and the level while pumping is known as the *drawdown* (see Figure 3). Drawdown in a well is the result of loss of head as the water moves with increasing velocity through the pore spaces or crevices of the aquifer toward the well plus some frictional losses in the well. The loss of head is in part proportional to the velocity of the water—thus the faster the water moves, the greater the drawdown. Within certain limits, the drawdown of a well is directly proportional

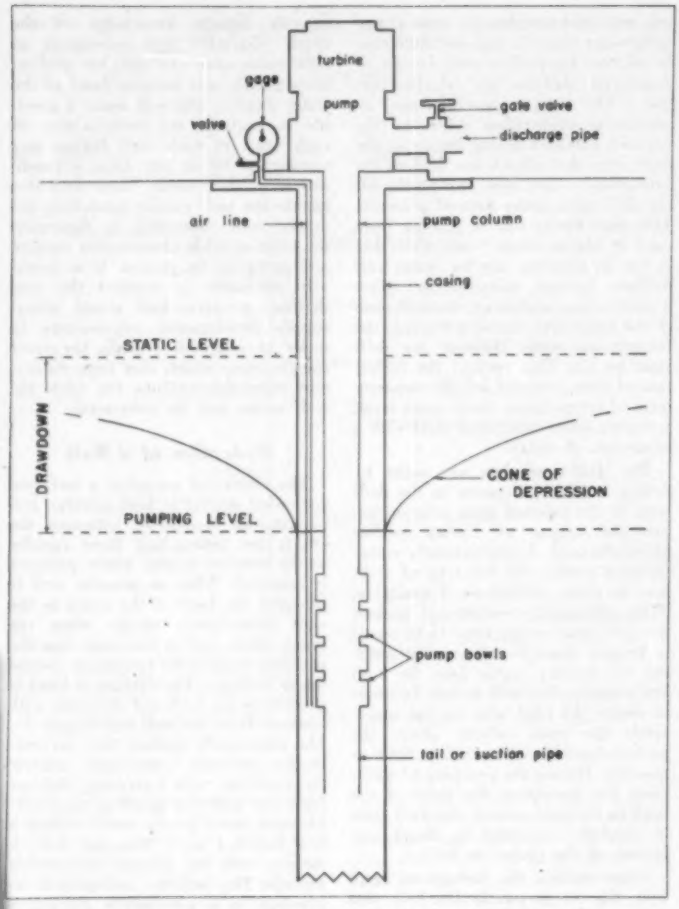

Figure 3. Turbine Pump Installation with Air Line for Measuring Drawdown.

to the amount of water being drawn from it.

Water wells are classed by most drillers as either rock wells or sand wells, which require different methods of construction and development (see Figure 4). *Rock wells* are those which supply water from hard or consolidated materials such as sandstone, and leached or fissured limestone and dolomite. Most deep wells drilled into the Paleozoic rocks of the Midcontinent region fall into this category.

Problem of Casing

The walls of some rock wells are so hard that no casing is required to hold the hole open and only a few joints of casing are needed below the surface to protect the well from surface drainage. In other wells, it is necessary to case the hole to the top of the aquifer in order to shut out objectionable water from upper beds or to prevent caving of soft beds. In either type, the well may be completed without a screen. This is known as *open-hole completion* (Figure 4 A) and is common in water-flooding operations in Oklahoma and Kansas.

If the well is cased to the top of the aquifer, it may be finished with a screen, or with perforated or slotted pipe. In a rock well drilled in a firmly consolidated aquifer, a screen, perforated pipe, or slotted pipe, serves only as a strainer to hold out any large rock fragments. Because of the ease of completion, some rock wells are cased through the aquifer and then the casing is gun perforated opposite the aquifer (Figure 4 B). Such completions are common in oil fields where only small quantities of water are needed for drilling purposes, but obviously the maximum yield of an aquifer cannot be obtained with such completion, for the frictional loss through such openings is very great and the total area of openings through which water can enter the well is small. Ripping the casing opposite the aquifer is a similar method of completion.

Sand wells are wells that yield water from soft or loosely consolidated sand or gravel, or a mixture of both. Generally we think of such sand and gravel beds as being at the surface, but loosely consolidated sands may be present at considerable depths, as are the Pleistocene and Tertiary water sands of the Gulf Coast region in which fresh water is found to depths of more than 2600 feet in some places, as at Baton Rouge, La., and Houston.

Function of Screen

A sand well (Figure 4 C) is not properly finished without casing, screen, and back pressure valve. The function of the screen in a sand well is to permit and control the removal of clay, silt, and fine sand from the water sand by development methods leaving the relatively uniform coarse materials to transmit the water. Thus it acts as a stabilizer rather than a strainer.

In some cases where the water sand is very fine, the water sand is reamed out and carefully sized gravel is placed around the screen. This is known as a *gravel-pack* well (Figure 4 D). If the entire well is reamed out and the gravel is placed around the casing as well as the screen, from top to bottom, the result is a *gravel-wall* well (Figure 4 E). *Gravel-pack* or *gravel-wall* wells are advantageous in fine sands under certain conditions, but it does not follow that all gravel-pack or gravel-wall wells will yield more water than a properly developed natural sand well. Uniformity of grain size is most important, not the maximum grain size. In some places, gravel-pack or gravel-wall wells represent not only an unnecessary expenditure of money, but an actual risk for no additional yield.

Well Development

Well development is the term applied to certain processes designed to increase the yield of a well by improving the permeability of the aquifer around the well.

Relatively few methods are available for increasing effectively the yield of rock wells. The processes used are limited to the shooting of the aquifer to increase the number and size of fissures in the rock, and the acidizing or other chemical treatment of limy sandstone, limestone, and dolomite beds. In some wells both are tried. These methods are not always success-

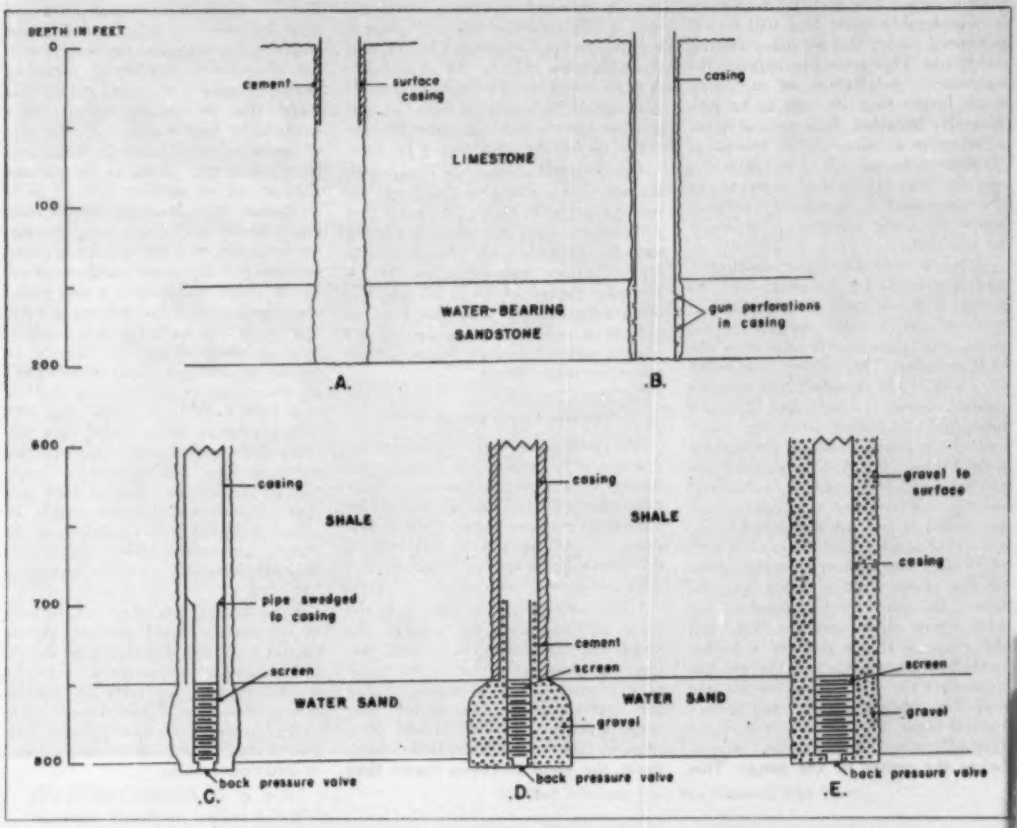

Figure 4. Methods of Completing Water Wells (A) Open Hole Completion of Rock Well, (B) Gun-Perforated Rock Well, (C) Screened Sand Well (D) Gravel-Pack Completion of Sand Well, (E) Gravel-Wall Completion of Sand Well.

ful and occasionally a well is lost by shooting. The newly introduced process in which oil reservoirs are fractured by hydraulic pressure may have some application to water wells but so far as the writer knows no such application has been made as yet.

Increasing Yield

In contrast to rock wells, much can be done to increase the yield of sand wells by development. This phase of water-well drilling is so important in large supply wells that it may be considered the difference between "hole punching" and true "well construction." The development of a sand well really begins with the mechanical analysis of the samples of the water sand. It is from these data that the screen is made up so that properly sized openings will be placed opposite the corresponding parts of the water sand. The proper size of the screen openings is not, as commonly thought, the size capable of holding out all sand but rather the size that will permit the grain sizes composing from 50 to 80 percent of the water sand to pass through the screen and out of the well, thereby increasing the permeability of the water sand around the well and reducing the turbulence frictional losses of the water entering the well.

After the screen has been made up, it may be lowered into the hole on the end of the casing or, if the casing has been installed already and cemented above the water sand, the top of the screen may be swedged inside the casing so that the screen extends through the water sand (see Figure 4 C). The latter type of construction is advantageous if the screen has to be removed at a later time. If the well is to be a gravel-pack or gravel-wall well (see Figures 4 D and 4 C), carefully graded gravel is placed around the screen, generally by means of conductor pipes along the outside of the casing. The well is then ready for development by surging, backwashing, or overpumping, or by a combination of these processes, prior to the permanent installation of a pump.

The surging of a well is accomplished by operating a surge plunger up and down in the well casing forcing water in and out the screen in such a way that the fine sand moves into the well. This fine sand is removed by bailing and the process is repeated until little or no sand enters the well. The in-and-out motion of the water through the screen is particularly effective, as it does not permit fine sand grains to bridge behind coarser grains.

Technique of Backwashing

Backwashing is similar to surging except that the in-and-out motion of the water through the screen is caused by the alternate application and release of compressed air, by the alternate starting and stopping of a pump, or by the actual pumping of water into the sand. There are numerous variations of this method, including one in which dry ice is dropped in the well for the surge effect.

Overpumping involves pumping the

well at such a rate that the drawdown is considerably more than will be experienced under the normal pumping conditions. This generally requires the temporary installation of a pump much larger than the one to be permanently installed. This method is not as effective as some of the others, as the flow of the water is in one direction and the fine grains tend to bridge in the water sand. It is sufficient in most wells where the quantity of water is no problem.

After a well has been developed, and it is ready for installation of the pump, it is advisable to set up a permanent air line for measuring the static and pumping levels after the well is sealed. This air line consists of $\frac{1}{8}$- or $\frac{1}{4}$-inch threaded and coupled copper, brass, or iron pipe, carefully measured, extending from the lower end of the pump bowls to the surface (see Figure 3). At the surface, an air valve, such as used on automobile tires, and a pressure (altitude) gauge graduated in feet are connected to the air line. Knowledge of the exact length of this air line measured to the center of the gauge permits ready calculation of the water level by pumping air with a tire pump into the line until the gauge will not register a higher reading. This means that the air has driven all the water from the air line and the reading on the gauge subtracted from the known length of air line will give the water level in feet below the center of the gauge. This can be accomplished both when the well is idle (static level) and when it is being pumped (pumping level), and the difference will be the drawdown. A pressure gauge graduated in pounds per square inch can be used on the air line but the readings must be converted to feet by multiplying by 2.31.

Upon installation of the pump with the attached air line, the well can be tested for yield. This is done by first determining the static water level and then pumping the well until the water level declines only very slowly. A pumping period of 24 to 48 hours is often adequate for this. The yield in gallons a minute is then determined with a weir, Parschall flume, orifice meter, or other means.

Specific Capacity of Well

The yield of a well divided by the drawdown is termed the *specific capacity*. It is a measure of the over-all well efficiency and the ability of the aquifer to transmit water. Thus a well pumping 500 gpm with 100 feet of drawdown has a specific capacity of 5 gpm per foot of drawdown.

In an artesian system and up to the point of dewatering the aquifer, the yield and drawdown of a well are about proportional—that is, the graph of different rates of pumping against the corresponding drawdowns for equal pumping periods results in a straight line. Under water-table conditions, the yield increases faster than the drawdown to a certain point and then declines—the graph of different pumping rates against the corresponding drawdowns for equal pumping periods results in a smooth curve. This means that the specific capacity of a water-table well varies with the rate of pumping and must be computed from the graph. However the specific capacity of an artesian well, if it is computed after essential equilibrium pumping conditions have been reached, can be safely used for estimating pump settings for any given yield required. In the above example, if a new pump is to be installed for delivering 1000 gpm from this well, the pump setting must be deep enough to tolerate an additional 100 feet (total of 200 feet) of drawdown or more. In a shallow well (200 to 500 feet deep), this 200-foot drawdown when added to a low static level might make such a low pumping level that continuous operation of the well at a rate of 1000 gallons a minute would be impossible. In a deep well, the same conditions might make an economically unfeasible, though physically possible, pumping lift.

Upon completion of a well, records of its pumpage and pumping levels should be begun. The pumpage should be recorded on a continuous basis; the water levels generally should be measured weekly. These records serve to give warning of water supply failure in time to provide needed repairs or additional wells.

* * *

SPECIAL INDUSTRIAL AWARD of the Greater Philadelphia-South Jersey Council was presented to Sun Oil Company in recognition of its significant contributions to the growth and development of the Philadelphia metropolitan area. Sun Oil president Robert G. Dunlop (left) is shown accepting the award from Colonel J. Harry LaBrum, chairman of the Governors Board of the Council. Sun was one of seven companies honored by the Council for its "faith in the future" as exemplified by its current expansion program.

* * *

Multibed Adiabatic Unit, Houdriforming Pilot Plant.

Application of Houdriforming to Produce Aromatics And High-Octane Motor Gasoline

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HOUDRIFORMING is a continuous catalytic reforming process applicable to the production of high-octane gasoline or aromatic concentrates. The reactions occurring in Houdriforming consist predominantly of dehydrogenation, isomerization, aromatization, and hydrocracking.

Presented here are data to illustrate the reactions which occur when processing pure hydrocarbons of different types as well as pilot unit data showing the results obtained from processing various charge stocks. The applications of Houdriforming to the production of benzene, toluene, and C_8 aromatic concentrates as well as high octane motor gasoline are illustrated by these data. This article is based on a presentation made before the Annual Technical Meeting of the South Texas Section, American Institute of Chemical Engineers, Galveston, October 19, 1951.

HOUDRIFORMING is a catalytic reforming process applicable to the production of both aromatic concentrates and high-octane motor gasolines from petroleum naphthas. Thermal and catalytic reforming of straight run naphthas have been subject to many developments in the course of the last 20 years. Thermal reforming adequately met the relatively low octane requirements prevailing in the past. However, as octane requirements have increased, thermal reforming has suffered largely from volume losses of liquid hydrocarbons to gaseous hydrocarbons. Catalytic reforming has been practiced mostly in the form of fixed bed hydroforming,

TABLE 1
Houdriforming of Cyclohexane
300 psi; H_2:Oil = 4 Moles

Severity	Cyclohexane → Benzene Conversion Percent	
	Found	Equilibrium Value
1	50	55
2	70	74
3	92	94

a process which involves operation at elevated pressure and with cyclic regeneration, requiring constant pressuring and depressuring of reaction vessels. Only recently have reforming processes been developed which permit the production of high octane number gasolines at high yields in a continuous operation requiring no regeneration or infrequent regeneration if operated at very severe conditions.

Houdriforming is a continuous catalytic reforming process. The reactions occurring in the Houdriforming of a naphtha charge are selective and consist predominantly of dehydrogenation, isomerization, aromatization, hydrocracking, and desulfurization. Dehydrogenation and dehydroisomerization of naphthenes permits the production of aromatic concentrates such as benzene, toluene, and xylenes from naphthene rich naphtha fractions. The same reactions plus isomerization of paraffins and aromatization of paraffins result in high yields of high-octane motor gasoline from straight-run naphtha fractions. In the production of both aromatics and high-octane motor gasoline, hydrogen is produced with good purity as a by-product of the process. The process is continuous at normal operating severity but, at conditions of extreme severity, periodic regeneration of the catalyst to remove coke may be necessary.

Several pilot units have been operating for the last two years at the Houdry Laboratories to obtain data on Houdriforming various charge stocks. Fundamental process data on pure compounds are obtained from isothermal reactor units. Actual processing data on typical naphthas are obtained with multiple reactor units in which the reaction is allowed to proceed adiabatically in each reactor to simulate proposed commercial operation. The number of reactors operated in series can be varied to give the desired results when processing different charge stocks. Since the major reaction is endothermic, interstage reheaters are provided between reactors to reheat the reactor effluent and thus supply the endothermic heat of reaction. Recycle hydrogen is separated from the liquid product in a simple gas separation tank at run pressure and room temperature and is compressed and charged along with the hydrocarbon feed. The hydrogen content of this stream varies from 86 to 98 percent, depending on the charge stock and operating conditions used. The quantity of recycle hydrogen is regulated so that a sufficient partial pressure of hydrogen is maintained to prevent or minimize coke deposition on the catalyst.

Houdriforming of Pure Compounds

The primary reactions occurring in Houdriforming and contributing to the upgrading of the charge stock are the dehydrogenation of C_6 ring naphthenes, the dehydroisomerization of alkyl cyclopentanes and the conversion of paraffins by isomerization, hydrocracking and aromatization. In normal operation it is obviously impossible to follow completely each one of these reactions because of the complexity of the feed stock and the interaction of hydrocarbons in the feed stock.

In experimental units it is possible to charge pure compounds and to analyze reaction products for the individual compounds formed. In this way, it is possible to follow the transformation of hydrocarbon classes within certain limitations. The conclusions resulting from such pure compound work, of course, are not entirely applicable to mixed feed stocks. In the latter case there is competition between the various types of hydrocarbons for the active sites of the catalyst. Due to preferential adsorption of certain types of hydrocarbons on the active sites, these sites may be denied to other types of hydrocarbons with a resulting suppression or reduction in the rate of specific reactions. Even so, it is interesting to note the extent to which pure hydrocarbons react. The processing of pure hydrocarbons offers a good means of testing catalyst activity for specific reactions.

Table 1 shows the conversion of cyclohexane to benzene over a typical Houdriforming catalyst at 300-psig pressure, a hydrogen to oil molar ratio of four, and three different severities obtained by changing temperature and space rate. Comparison with equilibrium conversion under the same conditions shows that equilibrium was essentially reached at each level of severity.

Methylcyclopentane is the most difficult of the alkyl cyclopentanes to dehydroisomerize. Its conversion to benzene therefore constitutes a severe test for catalyst activity. If one disregards side reactions such as cracking or ring splitting, methylcyclopentane will be converted to benzene in yields corresponding to 80-90 percent of the calculated thermodynamic equilibrium yields. Due to the uncertainty in the calculation of equilibrium values, the reaction must be considered as proceeding essentially to equilibrium. This dehydroisomerization is relatively slow and yields approach equilibrium as space rate declines. The amount of cracking occurring is, of course, influenced by operating conditions and also by the amount and nature of other compounds present.

TABLE 2
Houdriforming a C_6 Fraction for Benzene Production

Debutanized Liquid, Volume Percent Charge		87.9
C_4's, Volume Percent		2.6
Propane, Weight Percent		0.9
Ethane, Weight Percent		0.6
Methane, Weight Percent		0.4
Hydrogen, Weight Percent		3.4
Analysis: Vol. Percent	**Charge**	**Debutanized Liquid**
Benzene	2.7	51.2
Toluene	....	2.9
Methylcyclopentane	56.7	12.0
Cyclohexane	27.4	1.1
Heavier Naphthenes	....	0.8
Olefins	....	1.8
Paraffins	13.2	28.2

TABLE 3
Houdriforming a C_6 - C_7 Fraction for Benzene and Toluene Production

Debutanized Liquid, Volume Percent Charge		89.3
C_4's, Volume Percent		2.6
Propane, Weight Percent		1.1
Ethane, Weight Percent		0.3
Methane, Weight Percent		0.2
Hydrogen, Weight Percent		2.7
Analysis: Vol. Percent	**Charge**	**Debutanized Liquid**
Benzene	1.4	15.6
Toluene	4.6	31.7
Methylcyclopentane	4.6	2.8
Cyclohexane	13.9	0.8
Dimethylcyclopentanes	9.6	3.0
Methylcyclohexane	23.1	0.3
Olefins	....	0.9
Paraffins	42.8	43.1

Normal heptane can be chosen as a typical paraffin stock for Houdriforming operations. Wide variations in product distribution can be obtained by changing catalyst composition and operating conditions. At mild operating conditions, approximately 9 percent aromatics, mostly toluene, are obtained from normal heptane. The molar ratio of iso to normal paraffin in the C_7 fraction of the product is approximately 1.5. At more severe conditions the aromatics content will increase to about 15-16 percent and the iso to normal ratio of the C_7 fraction will increase until hydrocracking of the isoparaffins formed becomes the predominant reaction. The most favorable operating conditions must therefore be selected on the basis of products desired (aromatics or isoparaffins).

Aromatics Production

The petroleum industry is currently faced with the problem of alleviating the critical shortage of benzene, toluene, and xylenes needed for the defense

effort and for the expanding chemical and plastics industries. The reactions promoted by a Houdriforming catalyst can be applied to closely cut naphtha fractions for the production of these specific aromatics. The charge stock to such an operation may include a combination of benzene, toluene, and xylene formers, or it may be so fractionated as to include formers for only one of these aromatics. The choice of naphthenes to include in a charge stock will depend, in part, on the type of charge stock, the desired yield of specific aromatics, and the separation scheme to be used. Best yields of aromatics will be obtained by running closely cut fractions resulting principally in the formation of only one of the aromatics. However, economic considerations will in certain cases favor an operation in which a blend of aromatic formers is charged.

The results of processing a closely fractionated naphtha containing only C_6 hydrocarbons are presented in Table 2. This stock, because of its high content of methylcyclopentane (56.7 volume percent), presents a rigid test material for an aromatics producing catalyst. In a once-through operation, a debutanized product containing 51.2 volume percent benzene and 3.9 volume percent toluene was obtained. Higher conversion of the naphthenes is possible by increaing the severity of operation, however, the conversion efficiency* is markedly reduced. The most efficient conversion of naphthenes would be obtained with a recycle operation at sufficiently mild conditions to keep side reactions negligible.

Another typical naphtha, fractionated to contain only benzene and toluene formers, was processed and the results are presented in Table 3. In a once-through operation, a debutanized product containing 15.6 volume percent benzene and 31.7 volume percent toluene was obtained. This yield of aromatics represents approximately 90 percent total conversion of naphthenes to aromatics. This high conversion of naphthenes was accomplished with very little loss due to side reactions. Approximately 1300 standard cubic feet per barrel of 98 volume percent hydrogen is produced as run gas from this charge stock. Since no CO or CO_2 is present in this hydrogen, it is a more useful product for most purposes than hydrogen of similar or

* Defined as, $\frac{\text{naphthenes converted to aromatics}}{\text{naphthene disappearance}}$

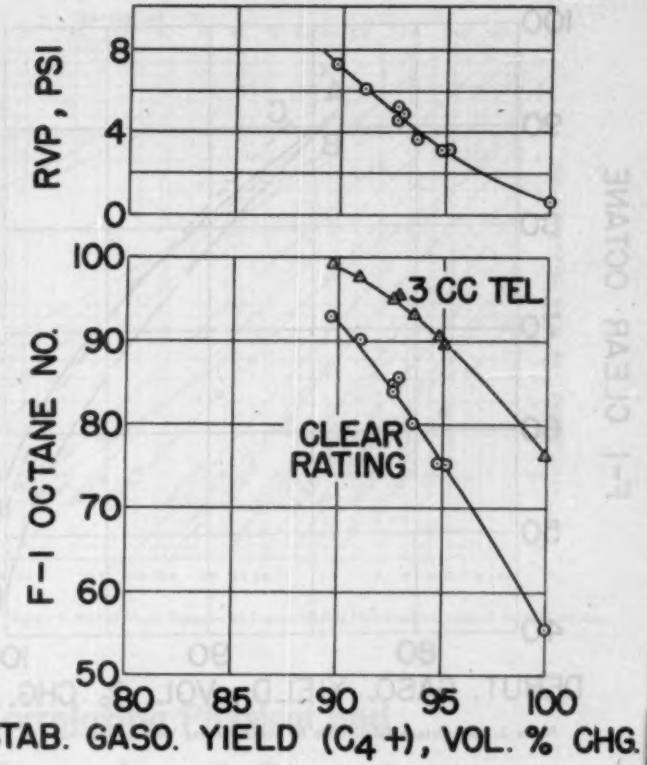


Figure 1. Octane Number and RVP of Stabilized Gasoline as Functions of Yield.

TABLE 4
Houdriforming C_6 Fractions for Aromatics Production

C_{5+} Liquid, Volume Percent Charge	91.1		87.1	
C_4's, Volume Percent	1.8		3.6	
Propane, Weight Percent	0.9		1.3	
Ethane, Weight Percent	0.4		0.8	
Methane, Weight Percent	0.2		0.8	
Hydrogen, Weight Percent	2.1		2.2	
Analysis: Volume Percent:	**Charge**	**C_{5+} Liquid**	**Charge**	**C_{5+} Liquid**
Toluene		5.4		2.5
C_8 Aromatics	1.9	30.3	8.0	40.9
C_9 Aromatics	1.1	5.1		18.4
Naphthenes	42	2.0	61	2.0
Olefins		2.0		2.0
Paraffins	55	55.2	31	34.2
F-1 Octane No.: (Total C_{5+} Liquid)		....		94.3
F-1+4.6 cc TEL Aviation Blending P.N. (Aromatic Portion)		190		230

TABLE 5
Houdriforming Naphthas for Motor Gasoline Production

Charge Stock	**A**		**B**		**C**	
C_{5+} Liquid, Vol. Percent Charge	85.8		84.3		86.6	
C_4 Cut, Vol. Percent	5.2		7.2		6.1	
Propane, Weight Percent	2.9		4.0		3.0	
Ethane, Weight Percent	1.7		1.8		1.8	
Methane, Weight Percent	0.9		1.0		0.7	
Hydrogen, Weight Percent	1.3		0.8		0.6	
Inspections of C_{5+} Liquid	**Charge Stock**		**Charge Stock**		**Charge Stock**	
Gravity, °API	55.3	48.2	52.7	44.1	51.6	47.1
Distillation, ASTM, °F.:						
I.B.P.	188	148	238	152	230	138
10 Percent	215	200	266	224	247	208
50 Percent	252	254	300	286	286	274
90 Percent	317	326	358	354	354	358
E. P.	368	385	396	438	396	438
Octane Numbers:						
F-1 Clear	55.6	89.1	42.5	90.3	51.5	90.3
F-1+3 cc TEL/Gallon	76.3	97.1	65.8	97.4	66.8	97.4
Reid Vapor Pressure, psi.	0.7	2.4	0.7	2.7	....	3.0
Chemical Composition:						
Paraffins	44	41	44	40	34	38
Olefins	0	1	1	2	0	2
Naphthenes	42	3	43	1	52	5
Aromatics	14	55	12	57	14	55

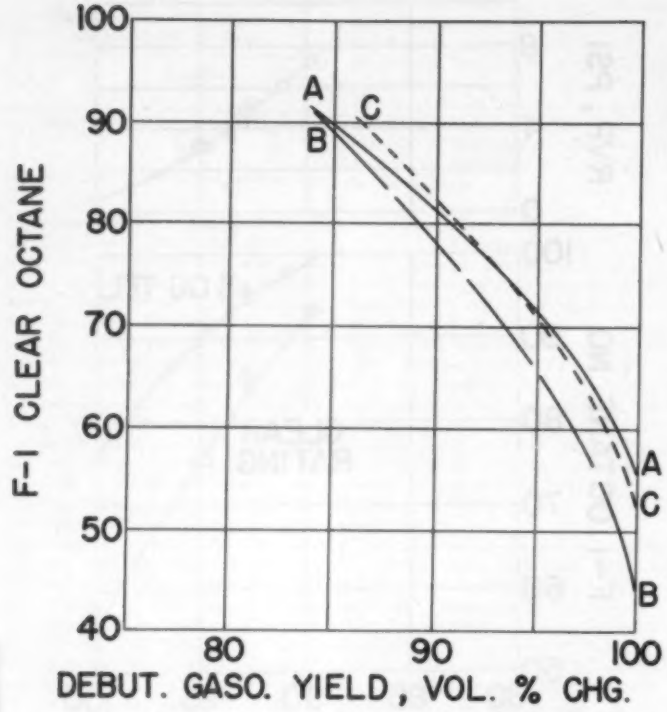


Figure 2. Yield-Octane Relationship for Houdriforming Various Naphthas.

higher purity obtained in a hydrogen plant using a water gas shift reaction.

Houdriforming is also applicable to the production of C_8 aromatics for use as chemicals or in aviation gasoline blending stocks. Table 4 presents data obtained from processing two different fractions containing predominantly C_8 hydrocarbons. The first stock contained 42 volume percent naphthenes and yielded a product containing a total of 40.8 volume percent aromatics. The aromatics when separated from the liquid product had an aviation blending performance number of 190 (F-4 + 4.6cc TEL). The second charge stock shown in Table 4 contained considerably more naphthenes (61 volume percent) and yielded a product containing 61.8 volume percent aromatics. The aromatics from this product had an aviation blending performance number of 220 (F-4 + 4.6cc TEL). In both cases very little hydrocracking occurred as evidenced by the low yields of butanes and lighter hydrocarbons.

Motor Gasoline Production

High yields of high-octane motor gasoline are obtainable from straight-run naphthas. Figure 1 presents the Reid vapor pressure, octane number and yield of C_4+ motor gasoline obtained when processing an East Texas type naphtha. The data presented were obtained by varying space rate and temperature at a constant pressure and recycle gas to oil mole ratio. A 93 F-1 clear octane gasoline with a Reid vapor pressure of 7.2 psi was obtained at a yield of 89.7 volumes percent. Under all of the conditions used to obtain the data in Figure 1, outside butanes are required for 10-pound RVP gasoline.

More detailed data for an East Texas type naphtha and two other naphthas are presented in Table 5. Inspections of the charge stock, and yields and inspections of the C_5+ product are presented. At the 90 F-1 clear octane level, the yields of C_5+ product for the three stocks range from 84.3 to 86.6 volume percent with yields of butanes ranging from 5.2 to 7.2 volume percent. In all cases there is an increase in ASTM distillation end point of the product over that of the charge. However, this increase is to be expected when converting naphthenes to the corresponding aromatics.

The yield of C_5+ product vs F-1 clear octane number for each of the three stocks is presented in Figure 2. Although starting at different octane levels, each of the stocks yields approximately the same volume percent gasoline at the 90 F-1 clear octane level. The curves as shown in Figure 2 show no sharp decrease in yield for a given octane improvement. It must be expected that a sharp break in the curve will occur at some point because of excessive hydrocracking. However, excessive hydrocracking was not encountered at any condition of severity used in processing these charge stocks. The hydrogen content of the run gas and recycle gas for these operations varied between 86 and 96 volume percent depending upon the severity of operation. It is of interest to mention that the data presented for motor gasoline production were obtained with catalysts having previous continuous operating histories of from 800 to 1400 hours and therefore represent performance of well aged catalyst.

Conclusions

High yields of benzene, toluene, or xylenes are possible from the Houdriforming of close cut naphtha fractions. Conversion of naphthenes to aromatics of up to 95 percent of equilibrium are obtained along with large quantities of 98 volume percent purity hydrogen. Low octane straight-run naphthas can be processed to high yields of high-octane motor gasoline. Data presented for a few feed stocks show yields of debutanized motor gasoline up to 86.6 volume percent of charge when processing to the 90 F-1 clear octane level.

* * *

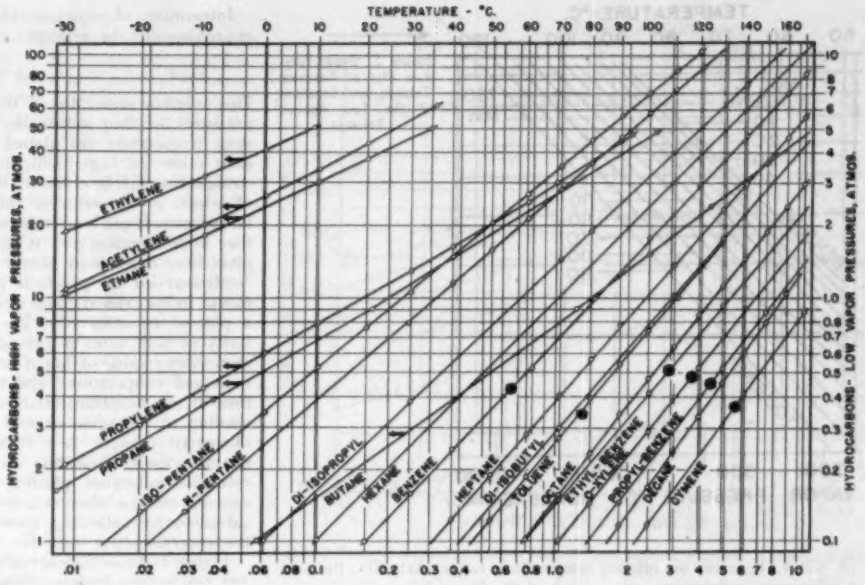


Figure 1. Plot of Vapor Pressure of Representative Hydrocarbons against that of Hexane.

Correlating Physical and Thermodynamic Properties

Part I

DONALD F. OTHMER and ROGER GILMONT
Polytechnic Institute of Brooklyn

THE METHODS described in this article for the correlation of physical chemical data used in petroleum technology depend on the comparison of the properties of one substance with those of another substance under the same conditions, both by algebraic methods based on sound thermodynamic equations, and geometric plotting. While the methods have been developed generally and have many applications in other branches of chemical engineering and physical chemistry, many are particularly useful in the petroleum industry.

Dr. Othmer is professor of chemical engineering and head of the department, Polytechnic Institute of Brooklyn and whereas Dr. Gilmont has been connected with the same institution, his present address is The Emil Greiner Company, New York.

NO SUBSTANCE is a "perfect" gas, liquid, or solid, and the deviations from "perfection" (i.e., the exact following of physical laws) of many properties of different real substances tend in the same direction. Thus, if instead of deriving equations or plotting absolute values of properties of one substance against temperature, these are considered and plotted against properties of another substance always taken at the same temperature, an opportunity is given for smoothing the irregularities of the properties of the substance by balancing them against those of the other.

A second major attempt has been the derivation of equations and the development of them graphically so as to give straight line plots which will take advantage of the simplicity and precision of extrapolating and interpolating data as well as minimizing the amount of experimental data required.

The classic example of a plot which balances relative values of properties of two different substances rather than plotting absolute values of one is that of Duhring, wherein approximately straight lines are obtained by plotting temperatures at which aqueous solutions boil against the temperature at which water boils at the same pressure. Perry and Smith[26] showed that improvements were obtained by plotting the reciprocal temperatures of the boiling solution against the reciprocal temperatures of boiling water, always at the same pressures. However, there is a certain inconvenience in plotting temperatures, or reciprocal temperatures, on both axes, since temperature is usually the independent variable. A more convenient method is that of plotting pressures against pressures. Such methods have been developed by Othmer and co-workers[6-25] to cover a large number of other properties, and it has been shown that straight lines may be obtained in plotting many of these properties against each other, or against the vapor

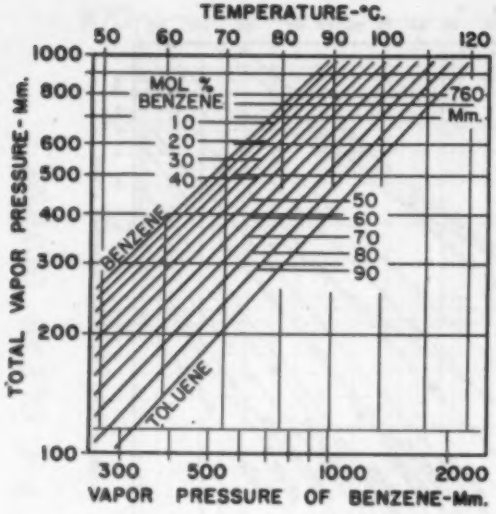


Figure 2. Vapor Pressure Plot of Benzene, Toluene, and Solutions of the Two Against Benzene.

pressure of water, benzene or other convenient reference substances, always at the same temperature. Heat quantities, such as latent heats, heats of solution, or of reaction are the controlling functions for the slopes of these lines. Furthermore, methods are obtained for giving straight-line plots of many properties, the plotting being made against temperature, which is the most common variable of interest in considering such properties. In still other cases, straight line logarithmic plots have been developed by Othmer and Gilmont[14] for various properties involved in distillation when plotted against total pressure on the system or against other combinations of properties.

Vapor Pressure and Latent Heat Single Components[6]

For correlating vapor-pressure data the starting point is usually the Clausius-Clapeyron equation. This is stated for one mole of material at the vaporization (or condensation) point where P is pressure, T is absolute temperature, L is latent heat per mole, and R is the gas constant:

$$\frac{dP}{dT} = \frac{LP}{RT^2} \text{ or } \frac{1}{L}\frac{dP}{P} = \frac{dT}{RT^2} \quad (1)$$

If this is integrated, assuming L constant over the range of integration, the resulting expression is:

$$\frac{1}{L} \ln P = -\frac{1}{RT} + C \quad (2)$$

where C is a constant of integration. Consequently, the plot of the logarithm of vapor pressure against reciprocal temperature can be used for a correlation to give a line that may be assumed straight over a narrow temperature range. Actually, the variation of the latent heat with temperature makes the line a curve. For a second material whose latent heat is L' and whose vapor pressure is P' (always at the same temperature T) there may be written an equation corresponding to equation (1).

$$\frac{1}{L'} \times \frac{dP'}{P'} = \frac{dT}{RT^2} \quad (3)$$

Since the temperature T is identical in both cases:

$$\frac{dT}{RT^2} = \frac{1}{L} \times \frac{dP}{P} = \frac{1}{L'} \times \frac{dP'}{P'} \quad (4)$$

Furthermore $dP/P = d \ln P$. Consequently, this relation becomes:

$$\frac{d \ln P}{d \ln P'} = \frac{L}{L'} \quad (5)$$

Equation (5) states that the ratio of molar latent heats at any temperature is equal to the ratio of the differentials of the logarithms of the vapor pressures at the same temperature.

If the ratio L/L' can be considered constant over certain ranges of temperature and pressure in question, then equation (5) represents a straight line when plotted in the variables dP/P against dP'/P' or $d \log P$ against $d \log P'$. Since these expressions are in the form of $x/y = a$, the straight line they represent goes through the origin. Thus, it follows that if a value of dP/P or $d \log P$ is known at any temperature, the plot of differentials of the vapor pressures can be evaluated against those of a reference substance over the entire range of temperatures. Consequently, the vapor pressures can be determined. In general, it is inconvenient to plot this differential form from tabulated data; and the form given below is of much more use.

Integration of equation (5) gives approximately the relation:

$$\log P = \frac{L}{L'} \log p' + C \quad (6)$$

This relation states that if the vapor pressures of two substances at the same temperature are plotted against each other on logarithmic paper, a straight line will be obtained, the slope of which is the ratio of the molar latent heats. It can be seen immediately that when equation (6) is plotted, it gives lines much more nearly straight (sufficient for all practical purposes except in the critical range) than does a plot of equation (3). The irregularity in both cases is caused by the diminishing value of latent heats with increased temperature; and the quotient of two quantities diminishing according to the same general pattern obviously changes less than either quantity itself. Thus, the use of the reference substance plotting method smooths out the idiosyncracies of one substance by balancing them against the corresponding ones for another.

Figure 1 shows the plot of equation (6) for various hydrocarbons against hexane as a reference substance. In most cases the equation is not needed, and vapor pressures are plotted on logarithmic graph paper (or logarithms of pressure values are plotted on ordinary graph paper) by three steps: 1) corresponding temperatures and vapor pressures of the reference substance are read from a table; temperatures are indicated on the X axis at appropriate values of pressures, with ordinates erected accordingly; 2) pressure is plotted from the logarithmic scale of the Y axis on these respective temperature ordinates so obtained; (the same pressure unit does not have to be used on both the X and Y axis, since there is a constant ratio between any two units; this ratio would merely move the line up or down on the plot without changing its form or slope); 3) points so obtained are connected by a line, which is straight. (In Figure 1 the drawing made from the original plot only has the ordinates of temperature shown; and these were superimposed on the ordinates representing pressures.)

It will be seen that this method of making the plot, while plotting pressures at the same temperatures, actually provides a temperature scale of ordinates to be used directly, and prepares the graph paper with pressures on the vertical axis against temperatures on the horizontal axis for direct plotting.

By a plot such as Figure 1, the vapor pressures over an entire range can be determined either from two values of vapor pressure of the material, or from one value and the slope

L/L′ when used in equation (6). (Since the latent heat of the reference substance is known at any temperature, the slope may be readily determined from knowledge of a single value of latent heat of one mole of the material.) In either case, it is convenient to take the normal boiling point for the one point. Since the ratio of molar latent heats with respect to the reference substance is found by determining the slope, this ratio can be used to determine the latent heats of the material in question at any desired temperature where the molar latent heat of the reference substance is known. If the lines are plotted on the same graph for families of materials, there are possibilities of other relationships existing between the curves, such as common intersecting points. This may even reduce the data necessary for a complete evaluation of properties of one material of a series to only one point (such as the normal boiling point), or to a slope, that is, one value of latent heat. A similarity is present here to the empirical Cox chart;[1] but it has been shown[6] that the intersection in a single point is only true for ideal solutions, and since the present plot does not include this assumption, it is more correct. Also, it has the major advantage of using standard graph paper and having the valuable heat relations involved in the slopes.

Note: For most engineering work, the slope of a line may be readily determined to the desired precision using a millimeter scale on a graph of ordinary size. A distance of 10 cm. is laid off horizontally from a point on the line, and a dot made on the paper. The vertical distance between this dot and the line, that is, the vertical leg of the right triangle of which the line is the hypotenuse, is measured in centimeters; when divided by 10 this gives the value of the slope of the line directly. Thus, if the distance was 6.45 cm., the slope is 0.645. The slope is the tangent of the angle, that is, the opposite side (the vertical leg) divided by the adjacent side (the horizontal leg) originally taken as 10 cm.

Interpolation and extrapolation of a plot such as Figure 1 may be done with considerable precision. Latent heats at any temperature may be determined through the use of the ratio L/L', the slope of the line, if L', the latent heat of the reference substance, is known at all temperatures (as it is if water or other common material is used as the reference substance). Values of L calculated from this plot are much more close to the actual value than those from plots made by using equation (2).

It is usually desirable that the critical points of the material and of the reference substance be in the same general range, since it is at the critical point that L becomes zero.

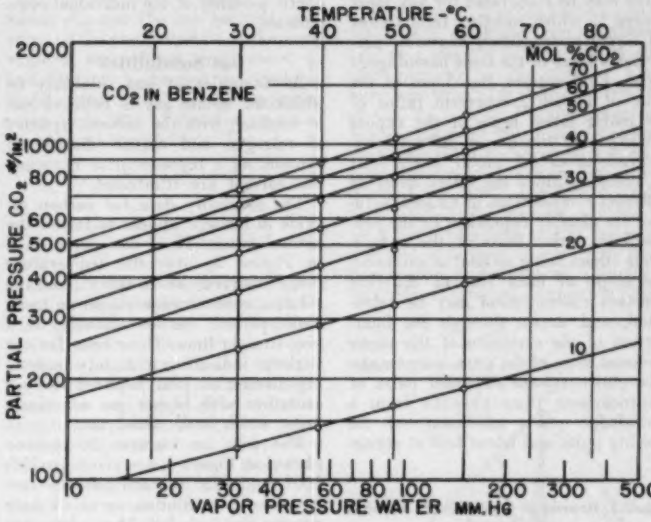


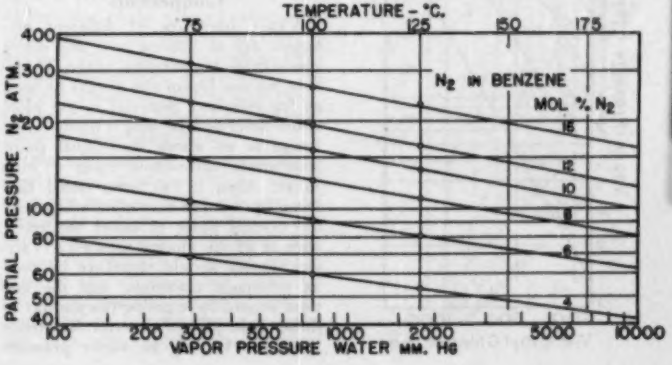
Figure 3. Partial Pressures of Carbon Dioxide from Benzene Solutions of Indicated Mole Percent Carbon Dioxide.

Vapor Pressure and Latent Heat Binary Mixtures[14]

The important interrelation of vapor pressures and the composition of mixtures of two volatile components is well illustrated by using as an example the system benzene-toluene. In Figure 2, against the network of ordinates representing both vapor pressures of benzene and corresponding temperatures, the lines representing vapor pressures of different benzene-toluene solutions are plotted.

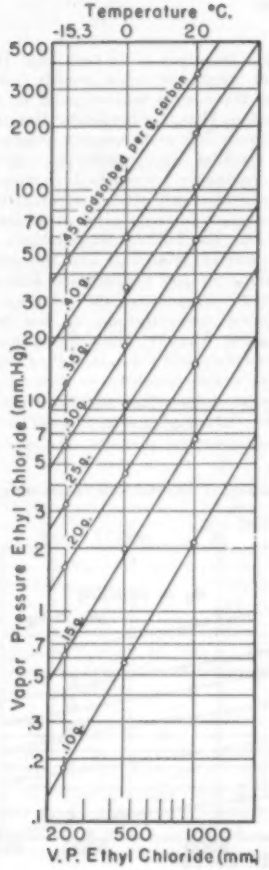
These lines are not parallel, but the slopes vary between the slope of the benzene (45°) line and the toluene line. Since all of the extensions of these lines intersect at the junction of the benzene and toluene lines, a single vapor pressure determination is all that is necessary to fix each line. This point might be most readily taken from the normal boiling point of the solution. Thus, the horizontal line representing 760 mm. pressure intersects the constant concentration lines at the corresponding normal boiling temperatures. Also, any other horizontal line at constant pressure gives at its intersections the boiling temperatures of the several solutions; and the intersections on any temperature ordinate give the pressures of the solutions of different concentrations at that temperature. Thus by using the common intersection and a single boiling point curve at one pressure—or vapor pressure vs. composition at one temperature—the complete system at all values of temperature, pressure, and compo-

Figure 4. Partial Pressures of Nitrogen from Benzene Solutions of Indicated Mole Percent Nitrogen.



sition may be elaborated for any ideal system, in which category falls almost all liquid hydrocarbon mixtures, particularly those of the same homologous series. Furthermore, the slopes of the lines of Figure 2 represent ratios of the molar latent heats of the vapors coming from solutions of different concentrations to the molar latent heat of benzene. Since the latent heats of different compositions of an ideal solution are directly dependent on the proportional latent heats of the components (there being no heat of solution) the slope of each line of different constant concentration may be calculated, and drawn through the intersection of the extension of the vapor pressure lines of the pure components. The entire system for most pairs of hydrocarbons thus results from a knowledge—as a minimum—of the boiling point and latent heat at atmospheric pressure of the individual components.

Figure 5. Isosteres of Ethyl Chloride Adsorbed on Charcoal.



Gas Solubilities[25]

As examples of gas solubility in which the solute gas is believed not to combine with the solvent, systems of nitrogen and carbon dioxide in benzene as a representative nonaqueous solvent are illustrated.

The solubility data for carbon dioxide in benzene appear to follow the normal trends. These data are plotted in Figure 3, over the temperature range involved, 30° to 60° C., and the solution concentration range, up to 70 mole percent carbon dioxide, they give straight lines. These lines fan out slightly, indicating a slightly increasing amount of heat required for gas evolution with higher gas concentrations, which is the usual case.

The data for nitrogen in benzene plotted in Figure 4, are given for 75°, 100°, and 125° C.; and nitrogen concentrations in solution up to 16 mole percent are included. These data give straight, practically parallel lines over the temperature range; but unlike the usual gas-liquid system, the slopes of these lines are negative. The solubility of nitrogen in benzene increases with temperature, as shown by the fact that a horizontal, or constant-pressure line, cuts higher valued concentration lines in going toward the right (higher temperature). The heat of evolution of nitrogen from benzene is negative; i.e., unlike any latent heat of vaporization, heat is given up and the liquid is heated by evolution of the gas.

Gas Adsorption[17, 21]

The application of logarithmic vapor-pressure plots, with a reference substance, to gas adsorption on solids such as activated carbon has been described.[17, 21] Straight lines are obtained, as shown in Figures 5 and 6, from which the heat of adsorption can be calculated.

Use of Critical Constants Single Components[7]

Vapor pressures of different materials are of interest over the entire conceivable temperature range. Therefore, no one liquid can always be used as the reference material in the plots above described, because it would either freeze or go above its critical point somewhere throughout such a wide range. Also, it has been noted that some lines curve somewhat when near the critical point of either the reference or of the plotted substance. Various liquids should therefore be used as reference materials, and the one used should have properties similar to those of the plotted material. Reference materials varying in vapor pressure properties between carbon dioxide and mercury have been used, so that the vapor pressures and critical points of the plotted material would not be too diverse from that of the reference material.

As an example may be cited the case of ammonia, which when plotted against water gives a line having a slope of 0.5206 throughout most of the range. Near the critical point, the curve bends slightly and the slope increases to a maximum of 0.5678. Probably the large difference between the critical temperatures of water and ammonia accounts for this change of angle and the corresponding calculated value of latent heat in this range. Chlorine may be used instead as a reference as it has vapor pressures and a critical temperature more nearly those of ammonia. When ammonia is plotted against chlorine, the deviation of the slope is much less; i.e., a much straighter line is obtained to represent the vapor pressures and latent heats.

The use of so-called reduced temperatures and reduced pressures, depending on critical constants, may be used to straighten the lines of the previous article right up to the critical points. These reduced values are not usually used unless considerable precision is desired in the critical range because: a) very satisfactory results are obtained on the direct plot; b) the calculations to and from reduced values are tedious; c) absolute values of temperatures and pressures which are used for reduced values complicate the plot; d) the critical values are known only for a relatively small number of compounds, although methods have been proposed for calculating them for others; e) the only substantial advantage shown by the use of reduced values is near the critical point; and this region only occasionally finds use in practice; f) in many of the most valuable uses of the plot, the vapor pressure of the reference compound itself was considered under some other condition, such as water out of an aqueous solution; and if the critical conditions are assumed to be the same, the reduced plot is the same as the simple plot.

Reduced values, like the method of plotting described, may however be used to balance even more closely the properties of different materials against one another in such a way that irregularities will be neutralized.

The reduced temperature for a given material is the ratio between the absolute temperature under consideration (in either degrees Rankin or Kelvin) and the critical temperature of the compound on the same scale. It is thus a dimensionless quantity for the

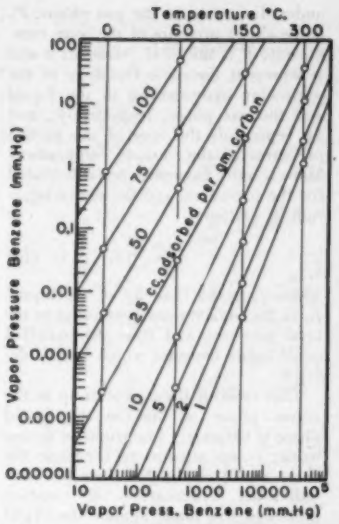


Figure 6. Isosteres of Benzene Adsorbed on Charcoal between 0° and 300°C.

particular material; obviously, at the same temperature as ordinarily considered, there will be a different value of the reduced temperature for every compound.

The reduced pressure likewise is the ratio of the absolute pressure exerted by the compound and its critical pressure. Thus,

$$T_R = T/T_c \text{ and } P_R = P/P_c \qquad (7)$$

where T_R and P_R are reduced values of temperature and pressure
T and P are normal values of temperature and pressure
T_c and P_c are values at the critical of temperature and pressure

Reduced pressure is also individual for every different compound at the same pressure. For example, the normal boiling point (1 atmosphere), when converted to reduced pressures is the reeciprocal of P_c measured in atmospheres. Thus, there is different reduced pressure for the atmospheric boiling point for every material.

An advantage of the units per se is that they are dimensionless; and reduced temperatures and pressures calculated in any English or metric unit may be used interchangeably with any other values calculated from other units.

When reduced temperatures and pressures are considered as a means of comparison in this method of plotting, the plot is of the logarithm of the reduced pressure of one substance against the logarithm of the reduced pressure of the other substance at the same reduced temperature for each. In the same manner as the equation previously obtained, the following general relation may be developed:

$$\log P_R = L_R L'_R \log P'_R + C \qquad (8)$$

where P_R and P'_R are reduced pressures of the two materials at the same value of the reduced temperature. L_R and L'_R may be termed the "reduced molal latent heats" of the respective compounds, also at the same value of the reduced temperature. Thus,

$$L_R = \frac{L}{T_c} \text{ and } L'_R = \frac{L'}{T_c} \qquad (9)$$

or

$$\frac{L_R}{L'_R} = \frac{LT'_c}{L'T_c} = m = \text{slope of line} \qquad (10)$$

The pencil of lines of Figure 7 represent reduced vapor pressures of the lower straight-chain hydrocarbons plotted against the reduced vapor pressures of water, always taken at the same reduced temperature. (Methane in this as other correlations is an exception and falls apart since it has no carbon to carbon bond.) To prevent confusion in the plot, only the points corresponding to the boiling points at 1 atmosphere are indicated, although the remaining data also fall on the indicated lines.

Of interest is the fact that every one of these absolutely straight lines goes through the reduced pressure point, 1,1, corresponding to the critical points of all of the plotted compounds and of water. This has an interesting and useful corollary. From the two-point-slope form of a straight line, when m is slope,

$$\frac{y - y'}{x - x'} = m \qquad (11)$$

there follows:

$$\frac{\log P_R - \log 1}{\log P'_R - \log 1} = m \qquad (12)$$

Since $\log 1 = 0$,

$$\log P_R / \log P'_R = m \qquad (13)$$

The last equation, showing the ratio of the reduced pressures as equal to m, may be equated to the ratio of the reduced latent heats, which also equals m, the slope of the line. Thus,

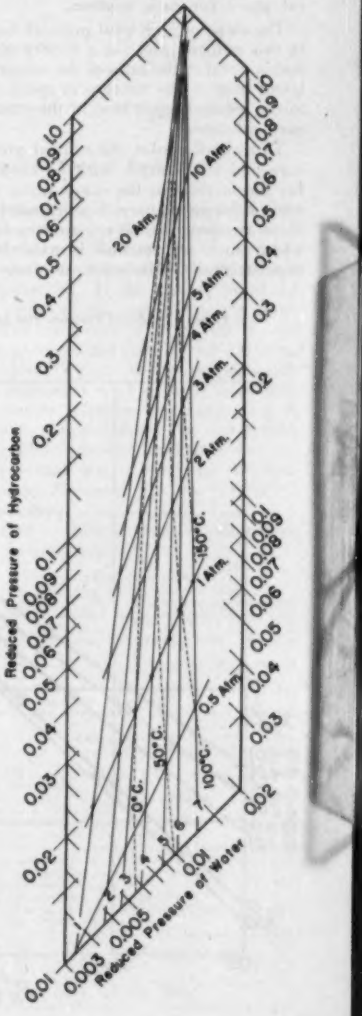
$$\log P_R / \log P'_R = L_R / L'_R \qquad (14)$$

This may be stated: at any given value of reduced temperature, the ratio of the value of the reduced pressure of any material to that of another is equal to the slope of the line on logarithmic coordinates representing the reduced pressures, and is also equal to the ratio of the reduced molal latent heats of these compounds.

One advantage of the above statement is that it allows, by the use of only one point of vapor pressure, the immediate and exact calculation of the vapor pressure and of the latent heat at any temperature up to the critical point of any substance for which the critical values are known or can be calculated. It is unnecessary to make any plot, since there is no constant to be considered or evaluated.

In Figure 7 all of the boiling points, which are indicated and numbered, fall on a straight line—a line of constant pressure (1 atmosphere). Lines have been drawn for constant pressures of 0.5, 1, 2, 3, 5, 10, and 20 atmospheres. Likewise the lines of constant temperature for these compounds have been determined; and a few lines, those of 50°, 100°, and 150° C., have been plotted. No attempt is made to work out a complete plot in this manner; but it is desired merely to show how such a vapor pressure plot for a homologous series of compounds might

Figure 7. Plot of Reduced Vapor Pressures on Lower Hydrocarbons.



be prepared wherein lines of constant temperature, constant pressure, and constant reduced pressure all are straight.

Binary Mixtures[15]

Following the previous technique,[7] the logarithm of the reduced total pressure of the binary system at constant composition may be plotted against the logarithm of the reduced pressure of a reference substance (which may be one of the components of the system); both reduced pressures taken at the same reduced temperature. This gives a series of lines (isosteres) taken at suitable constant compositions to describe the system completely. All of these lines pass through the origin, which represents the critical point for each isostere.

The slope of each total pressure line in this reduced plot for a binary system is equal to the ratio of the reduced latent heat of the mixture in question to the reduced latent heat of the reference substance.

To make this plot, the critical pressure and temperature must be known for the mixture at the composition of each different isostere. Unfortunately, there are very few binary systems for which such information is available experimentally. Moreover, no simple relation exists between these variables and the critical constants for the pure components, as is apparent from the systems for which data are available. Kay's rule[5] which assumes that the critical value for the mixture is the average of those for the pure components weighted according to mole fraction, is about as applicable as Raoult's law, of which it is a specific case.

The data for the system propane-n-pentane are plotted against water as the reference substance in Figure 8. For this system the slope of the isosteres passes through a minimum. This is an indication that at a given reduced temperature (or pressure) the reduced latent heat of evaporation of the system as a function of composition passes through a minimum.

Vapor Composition Equilibrium Constant[6]

The vapor composition equilibrium constant is usually derived from Raoult's law,

$$p = P_v x \qquad (15)$$

and Dalton's law,

$$P = \Sigma p \qquad (16)$$

which, when combined with Avogadro's law, give the equilibrium relation:

$$p = P_v x = P y \qquad (17)$$

where, at a given temperature, p is the partial pressure of the hydrocarbon under discussion in the gas phase; P_v is the vapor pressure of the pure component; P is the total pressure; x and y represent the mole fractions of the particular hydrocarbon in the liquid and the gas phase, respectively; and Σp represents the sum of the partial pressures of the various components. More usually fugacities are substituted for the pressures, and the above equation is written:

$$\frac{y}{x} = \frac{f_p}{f_m} = K \qquad (18)$$

where f_p is the fugacity of the liquid, f_m is the fugacity corresponding to the total pressure, and K is the so-called equilibrium constant which is thus defined.

This ratio of the composition in the vapor phase to that in the liquid phase is extremely important in design work; in an attempt to correlate the data, a plot of the K values for each individual hydrocarbon at constant pressures was made against the vapor pressures of a reference substance at the same temperatures. (It was found that a plot of the vapor pressure of hexane, a typical hydrocarbon, against the vapor pressure of water at the same temperature gave a substantially straight line in the temperature range to be used. Because of the ease of working with the tabular data for the vapor pressure of water, water was used as the reference substance in all subsequent work; it follows that if straight lines are obtained when plotted against water, straight lines would also be obtained if plotted against the same or a different hydrocarbon.) As an example, Figure 9 is a plot of the K values of methane and of propane against the vapor pressures of water, which is similar to the usual plot for pressures.

The lines plotted in Figure 9 would be expected to be straight from an algebraic consideration of the relations involved, for those cases where Raoult's, Dalton's, and Avogadro's laws hold. If values of y in equations (17) and (18) are equated,

$$\frac{P_v x}{P} = y = Kx \text{ or } \frac{P_v}{P} = K \qquad (19)$$

When logarithms are taken,

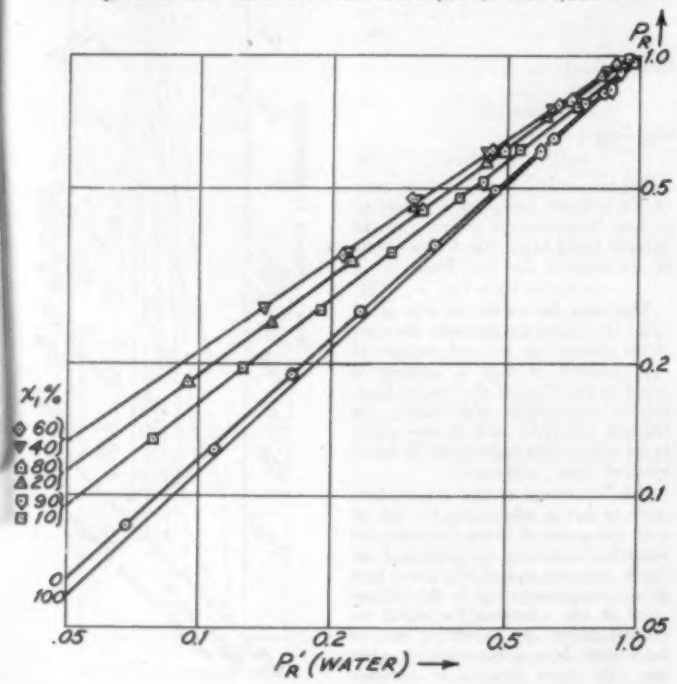
$$\log P_v - \log P = \log K \qquad (20)$$

If differentials are taken and the equation is divided by d log P_v,

$$\frac{d \log P_v}{d \log P_v} - \frac{d \log P}{d \log P_v} = \frac{d \log K}{d \log P_v} \qquad (21)$$

The first term is equal to unity. From previous work[6] it is known that $d \log P/d \log P_v$ (the slope of the straight line obtained by plotting P against P_v on logarithmic paper) is a constant; hence $d \log K/d \log P_v$ must also be a constant. This value is, however, the slope of the line of K plotted

Figure 8. Reduced Pressure Plot for Isosteres of Propane-n, Pentane System.



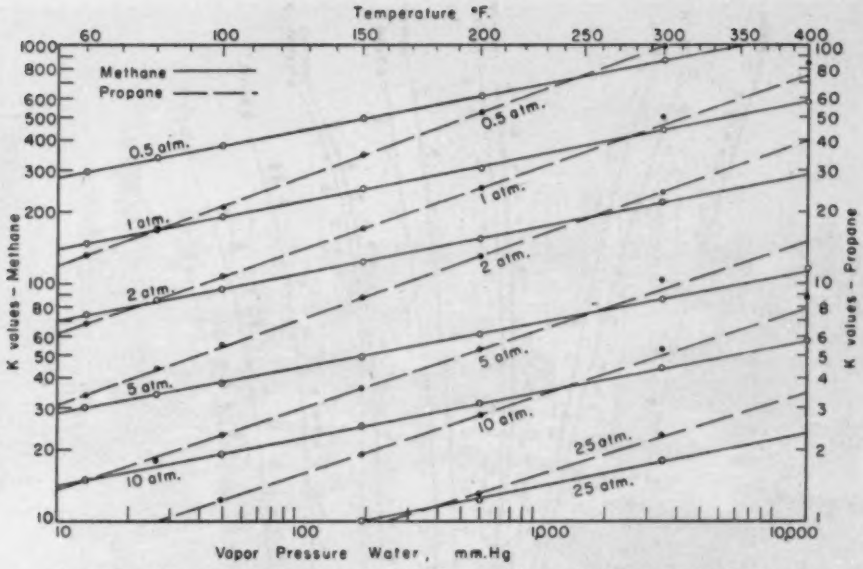


Figure 9. Vapor Composition Equilibrium Constant (K) Values of Methane and of Propane at Constant Pressures.

against P_v on logarithmic paper; if the slope is a constant, the line is straight. Thus:

$$\log K = a \log P_v + b \qquad (22)$$

where a and b are constants which depend, among other things, on the particular total pressure in question. Equation 22 is based on an assumption of Raoult's law and the gas laws. Where these do not hold, fugacities have to be substituted for pressures; and a similar equation would result which would hold over a wide range. The present correlation is most useful in the temperature and pressure ranges where the logarithmic plot of pressures holds; fortunately these ranges cover most of the field of engineering practice.

The lines of Figure 9 are drawn, using water as a reference substance; and its vapor pressure has a straight line relation with that of the individual hydrocarbons on this plot, as already indicated; hence adjustment of the values of a and b gives this equation based on the vapor pressure of the substance itself, if desired.

Deviations from Equation (22) and a straight line are probably within range of precision of the values given for K for these lower hydrocarbons. In extended ranges of temperature and pressure, the correlation may not be linear on the logarithmic plot; and the use of critical constants to give reduced values of the temperatures and pressures might aid the correlation.

Figure 10 is a nomograph presented by Scheibel and Jenny[28] based on the principles described above. The temperature scale is based on the logarithm of the fugacity of liquid pentane. The pressure scale is based on the logarithm of the fugacity of the vapor of pentane. For this calibration a curve passing approximately through the center of the range of fugacity variation was chosen. If the vapor fugacity were independent of temperature, all the component scales in the nomograph would be straight lines parallel to the pressure and temperature scales and logarithmically calibrated. The major deviations are compensated by the curved lines which result from the empirical construction of various compound scales. All of these scales were found by the intersection of line connecting the various temperature and pressure conditions which give the particular K value to be located.

A line connecting the given temperature and pressure intersects all the component scales at the values of the respective equilibrium constants (K values). Over the greatest range of conditions the nomograph gives values which agree with published data with an accuracy of about 2 percent. This is within the reliability of the basic data. However, at pressures greater than 300 and less than 10 psi., the deviation of the values given by the nomograph from the published data increases to about 10 percent or more at certain temperatures.

At high pressures the K values for the different components have been found to vary with the composition of the mixture. This variation is greatest as the critical point of the mixture is approached. At the critical point the K values of all components are unity.

For temperatures below 300° F. and for pressures between 10 and 300 psia., Figure 10 gives results which agree exceptionally well with the calculated K values. Outside this range, the K values obtained from the nomograph should be checked against actual experimental data in line with the limitations discussed in the preceding paragraph.

End of Part I. Part II will appear in an early issue.

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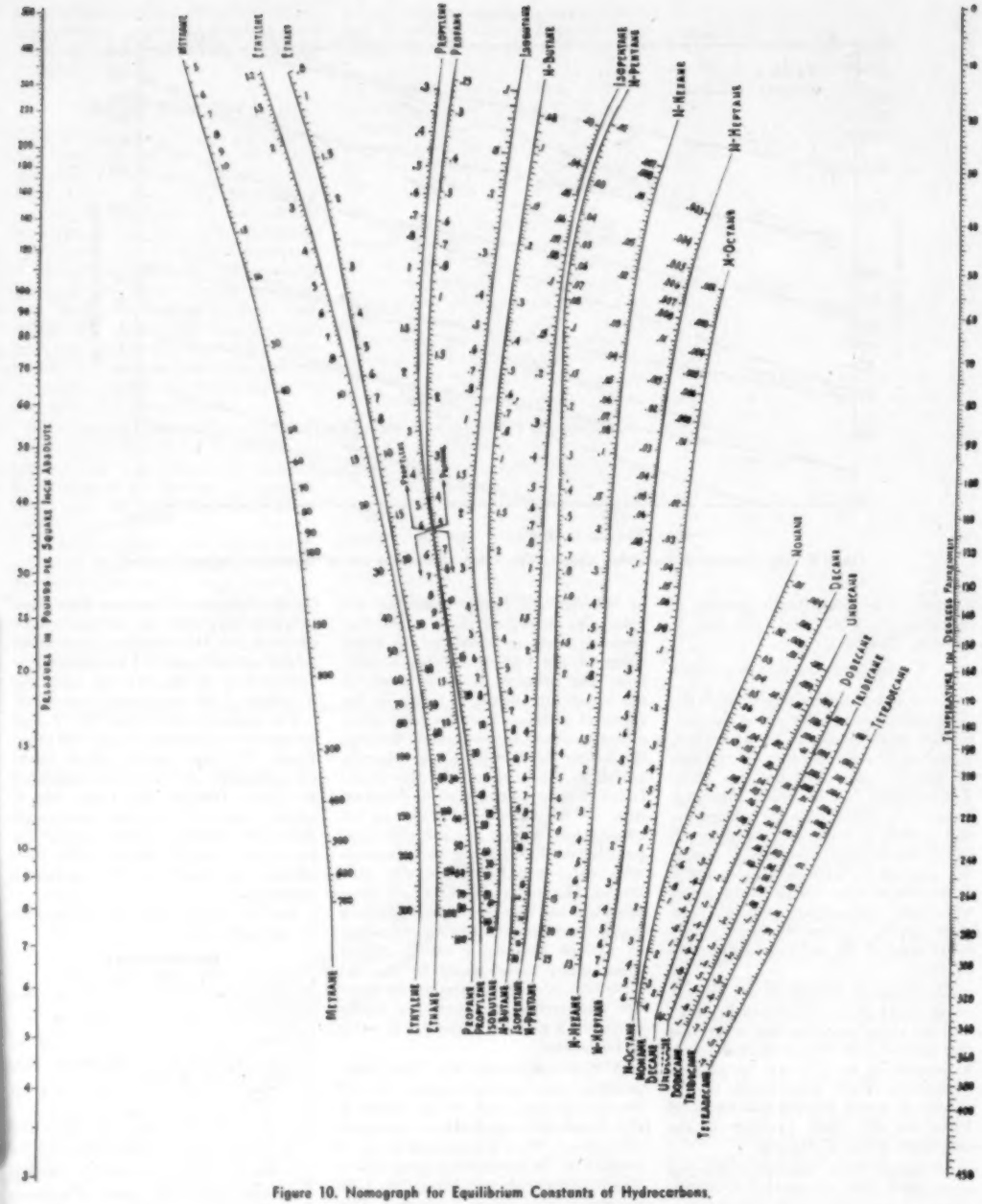

Figure 10. Nomograph for Equilibrium Constants of Hydrocarbons.

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ACKNOWLEDGMENT

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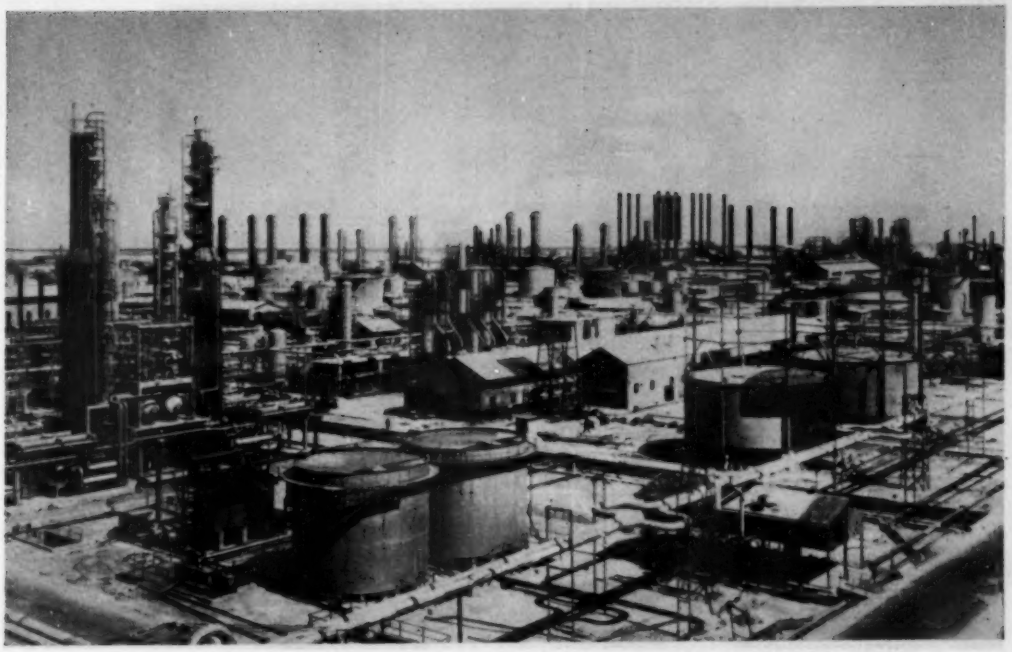


General View of Anglo-Iranian Oil Company's Abadan Plant, the Largest Refinery in the World. (Acme Photo.)

Abadan Refinery Tied Up Shortly After Big Cat Cracker Completed

TIED up after only three months of operation is the giant fluid catalytic cracking unit at Abadan at the head of the Persian Gulf which went on stream in April. By the end of that month it had completed one trial run at 29,000 barrels daily, and was being changed over for a second test, this time at 25,000 barrels daily.

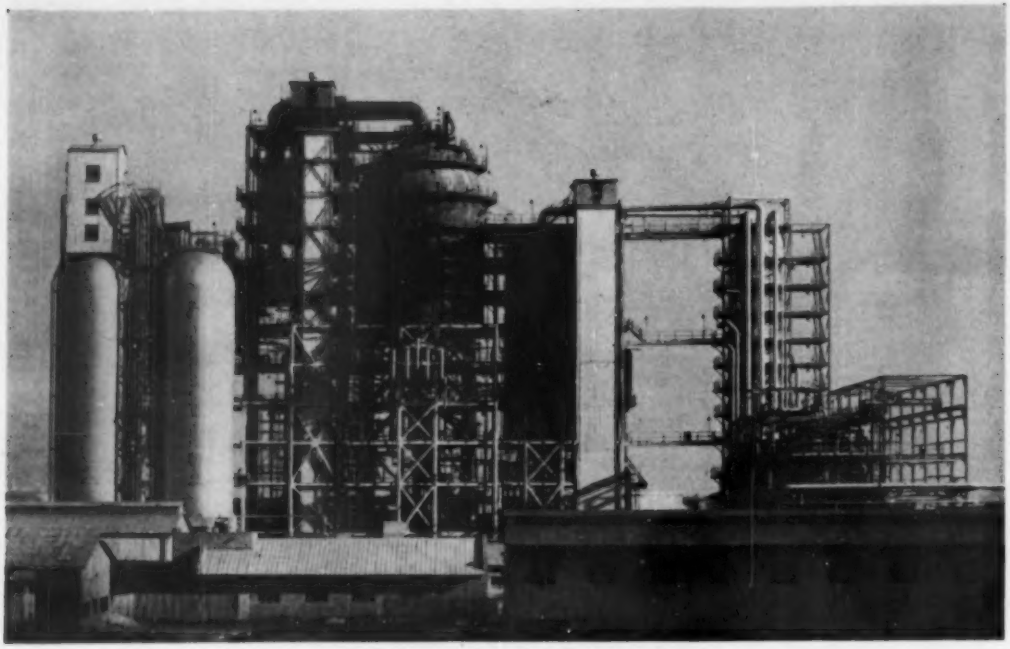
The Anglo-Persian (now Anglo-Iranian) Oil Company began building the Abadan refinery with an initial daily capacity of 8000 barrels in 1909, and completed it three years late. This pioneer Middle East refinery was enlarged and modernized on several occasions. The aviation gasoline plant, first brought into operation in 1940, was soon enormously expanded to meet enhanced Allied requirements, including those of Russia. From the standpoint of capacity the Abadan refinery, processing close on 500,000 barrels daily, is the world's largest undertaking of its kind. Crude oil distillation is effected with atmospheric and vacuum equipment, while thermal conversion facilities comprise a reforming installation with a rated capacity of 125,000 barrels daily.

The Development Section at the Sunbury Research Station of Anglo-Iranian Oil Company has a catalytic cracking pilot plant for producing high quality gasoline, employs 15 technicians and processes about 100 imperial gallons a day. Minor modifications effected to the Abadan "cat" cracker in the light of work at Sunbury, and elsewhere, are calculated to raise its capacity to 35,000 barrels daily at 48 to 50 percent volume conversion.

The Abadan Fluid catalytic cracking project was planned to improve the balance of white and black oils. The cat cracker has been designed for two operations, i. e., taking 25,000 barrels daily at a light product conversion rate of 55 percent, and coping with 29,000 barrels daily at a conversion rate of 45 percent. Input will, as noted before, eventually be stepped up to 35,000 barrels daily.

This giant cat cracker was designed by the Foster Wheeler Corporation of U. S. A. and built under the over-all supervision of its engineers. The gas plant was designed by E. B. Badger & Company, Ltd., and erected under the guidance of its engineers. Technical personnel from Matthew Hall & Company, several of the British staff of the Anglo-Iranian Oil Company, and nearly 900 skilled Persian workers assisted.

The capacity of existing facilities at Abadan are ample to provide suitable and adequate feedstock for the new cat cracker. Designed to operate with crudes above average in sulphur content, this installation incorporates separate reactor and regenerator vessels, a fractionator and feed pre-heater. It has, besides, catalyst coolers, waste heat boilers and electric precipitator. The cat cracker covers an area of 235 by 275 feet, and is 175 feet high, and has 13 floors served by two elevators. The weight of the bottom cone of the cracker exceeds 100 tons, and its skirt weighs 75 tons. The regenerator measures 47 feet in diameter, and one of the catalyst carrying lines is of 8-feet diameter. The two catalyst storage hoppers have a capacity of



The New Catalytic Cracking Unit at Abadan.

1500 tons, and one is constructed to take a temperature variation from atmosphere to 1,000° F. in a few minutes. This would come into use to take the catalyst should it be necessary to shut down the plant in an emergency.

The cat cracker produces gas and gasoline (to 400° F. end point), gasoil, cycle oil and clarified oil. The gas and gasoline stream amounts approximately to 45 percent by weight of the feed; the gasoil stream, 19 percent; cycle oil, 23 percent; and clarified oil from the thickener, 8 percent.

The gas and gasoline stream is processed in the gas plant. Here 90 percent of the butenes/butanes suitable for subsequent alkylation are recovered. Provision is made for 50 percent of the total propene/propane in the gas to be won as a separate stream containing about half the hydrogen sulphide produced in the cat cracker. Tail gas from the absorber units is led to the fuel system. The debutanized gasoline, approximately 3 percent by weight of fresh feed, is passed to the splitter column, in which light gasoline of 200°-260° F. end point is taken as an overhead product. Facilities for caustic washing the two gasoline streams before they are run to intermediate storage, form an integral part of the plant. Following further treatment the octane number of the total debutanized gasoline is over 80.

The gasoil stream is steam-stripped before passing to storage. It has a pour point of 0.5° F., and after treatment is suitable for use as a fuel diesel-blending stock. Because of the availability of sufficient fresh feed the cycle oil is utilized as a fuel oil blend stock. The only period when shortage of fresh feedstock is anticipated is during shutdown of the distillation units. Then the cycle oil stream can be recycled to the unit. Clarified oil is made use of as a fuel oil blend component.

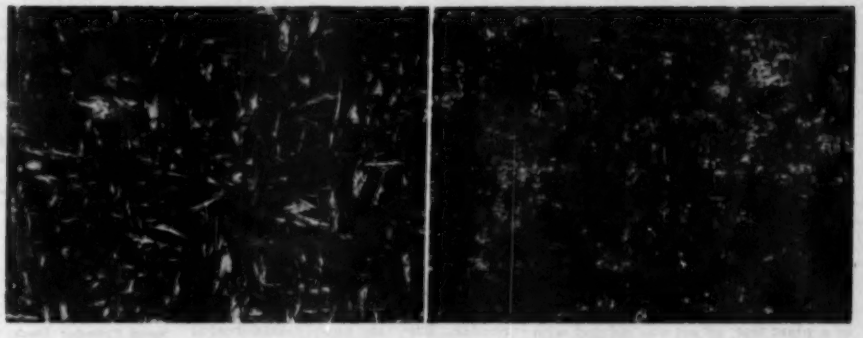
Both the reactor and regenerator are fitted with single-stage cyclone separators. The reactor and fractionator have 11-13 chromium-clad plate. The upper section of the fractionator is monel-clad, and the lower section alloy lined. The separator in the reactor is also of alloy construction. Each of the catalyst hoppers for fresh and hot storage is designed to hold the entire catalyst inventory. Refractory lining is employed in the used catalyst hopper. For charging the plant nearly 300 tons of catalyst are required.

The gas recovery plant, with a capacity of 21 million cubic feet per stream day, has eight compressors with a combined horse power of 3000. It is of the usual absorption type, and, in addition to depropanizer, debutanizer, etc., is provided with a gasoline splitter yielding light and heavy gasoline fractions. The absorber is designed to operate at approximately 52 psi. Refrigeration for this operation is provided by an ammonia absorption system.

The main gas supply for firing the catalytic feed preheater and steam superheater is obtained from the plant's absorber. The absorber overhead gas stream is tied into the refinery's regular fuel gas system to insure continuity of supply. In an emergency heaters may be fired with oil. Gas for the compressor engine fuel comes from the operations of the alkylation unit.

All of the main pumps and the single centrifugal compressor in the cat cracker are steam turbine driven. Superheat for the steam is supplied from the operation of the plant obtained with a fired unit adjoining the cracker. The refinery's regular steam system is tied into the catalytic unit's waste heat boilers and other steam generating equipment. Evaporators are in use to insure high-purity water for the cracking plant steam generators. Pure water is also employed to condition the flue gases passing to the electric precipitator, and to spray generated flue gas to forestall catalyst poisoning.

The catalyst, a synthetic product, is stored near the cracking plant hoppers, and ammonia on specially constructed racks, which are provided with a travelling crane to facilitate handling of large drums. The ammonia cylinders are of 8-cwt. capacity each, and are some of the largest ever made in Britain for shipment overseas. Auxiliary buildings include the main office and laboratory and an electrical sub-station.



Left-Slop Cut Wax. Right-Slop Cut Wax with 5 Percent Petrolatum. (Both x 112½.) Continental Oil Company.

Notes on DEWAXING—
Removal of Petrolatum

Part II. Removal of Petrolatum

—PAUL ZURCHER
Associate Professor, University of Tulsa, Tulsa

THE wax contained in the lubricating oil fractions of successively increasing boiling points crystallizes in smaller and smaller needles and as mal-crystals. The latter are indefinite clusters and twisted crystals. This wax is called petrolatum or ceresin, the latter name indicating the similarity of the physical and chemical properties of these hydrocarbons to those of the natural ceresins. Sachanen and others[1] published a comparison of ceresin or microcrystalline wax with paraffin wax of similar melting point as shown in Table A.

TABLE A

	Ceresin	Paraffin
Melting point	135.2° F.	134.5° F.
Spec. Gravity at 212° F.	0.785	0.757
Absolute viscosity (Poises)	0.0729	0.0264
Boiling point	1180° F.	885° F.
Molecular weight	893	400
Reaction with fuming acid	Active	Inactive

Ceresins have higher specific gravities, higher boiling points, higher molecular weights, and are more viscous than paraffin waxes of the same melting points. Ceresin waxes are attacked by sulfuric acid of 30 percent free sulfur trioxide at 212° F.

THE DEWAXING of oils by chilling and pressing or centrifuging has long been the "conventional" method for processing lubricating oils and continues in wide use even though there is a number of more "modern" solvent refining methods for dewaxing. In cases where the quality of the original stock is high and the capacity of the plant small, it is often difficult to justify the installation of the more expensive solvent refining methods. This article, of which Part II is presented here, reports many of the operating details of the pressing process.

The heaviest commercial paraffin waxes boil at 680° F. at 40 mm. absolute pressure, while the lightest ceresins boil at 670° F. Consequently, wax distillates of high end points contain ceresin wax, and the fractions boiling just above the end point of the wax distillates contain paraffin wax. Ceresins in relatively small amounts reduce the size of the parffin wax crystals to needles of such small dimensions that they cannot be separated from the oil by pressing. Paraffin wax in admixture in considerable quantities with ceresin renders the separation of petrolatum from heavy oils difficult. In order to avoid these troubles, the light and the heavy lubricating oil fractions are kept apart in the vacuum still by a so-called "slop cut" which contains both ceresin and paraffin waxes. Bestuzhev[2] states that upon rapid chilling the paraffin wax crystallizes in the microcrystalline form, a very important allegation generally ignored by operators of centrifuge dewaxing plants.

It has been established beyond doubt that some resinous or gummy material present in the heaviest fractions of the oils cause the wax to crystallize in small needles and mal-crystals required for successful centrifuging. This explains why residual stocks are generally more easily dewaxed than distillates, as they contain more of the crystal inhibitors than the latter. Overhead distillates are improved in their centrifuging quality by the addition of petrolatum from residual stocks, flux, Paraflow and similar complex compounds. Jones and Blachly[3] discussed these substances which change the surface tension of the system and thus affect the crystallization of the wax.

Ceresins from petrolatum differ from paraffin waxes particularly in their ability to hold oil which cannot be removed by pressing and sweating. This tightly adhering oil renders the petrolatum soft and amenable to separation by centrifuging.

Inspection of the petrolatum under the microscope yields no clue as to the centrifuging quality of an oil. A test based on the difference in specific gravity of paraffin wax and ceresin wax gives positive indication of the behavior of the charge to the centrifuges. The oils are diluted with naphtha and chilled in sample bottles to —15° F. If the crystals form a voluminous mass, they contain paraffin

wax of low specific gravity. Settling of the wax into a small volume indicates the absence of hard paraffin wax and good centrifuging quality.

Very important is the temperature to which the oil is heated before chilling. If a charge to the centrifuge plant is chilled from a temperature at which some of the wax is already crystallized, the test in the sample bottle may produce a fluffy suspension of the petrolatum. Heating of the oil before chilling to a point where all wax is dissolved will give a dense precipitate in the bottle. Applying this evidence to a plant test, an oil was diluted with naphtha, chilled without preheating, and centrifuged. The wax-free oil had a pour point of 20° F. When another batch of the same oil was heated to 120° F. before chilling, the pour point of the dewaxed oil was 5° F.

Taking advantage of the knowledge that the regulators of the crystal size are in the highest fractions of the petrolatum, one may centrifuge stocks of 100 S. U. viscosity at 100° F. or less, by adding considerable quantities of petrolatum from residual stocks to the charge oil. Distillate stocks of higher viscosities are similarly benefitted by the incorporation of residual petrolatum.

In centrifuging, the petrolatum is recovered from the oil as a mixture of solid ceresin, highly viscous oil, certain amounts of resinous and coloring matter, and solvent naphtha. The composition of this petrolatum varies with the charge and the operating conditions. On the average, the volumes of solid wax, oil and solvent are approximately equal. The melting point of the wax separated from oil and solvent may be as low as 120° F. and as high as 180° F. Ceresins produced from long residual stocks may have lower melting points than those from distillates.

Charge Stocks

The choice of the crude oil depends on the kind of lubricating oil desired and on the quantity of lubricating oil fractions present. Very small amounts of lubricating oil and high asphalt content in a crude oil may render the production of lubricants uneconomical. Pour point depressants are indicated for oils of low wax content. However, these additives have little effect on microcrystalline wax.

A true boiling point distillation followed by treatment of large batches in a pilot plant are the only means of determining the possibilities of a lubricating oil fraction in a crude oil. Distillates and residual stocks are made and refined exactly like in large-scale operation. The products are blended and their properties determined.

Bright stocks are made from so-called residual cylinder stocks by treating reduced bottoms of green crudes. Average Mid-Continent oils and black oils contain so much asphaltic matter in the heaviest fractions that its removal by acid is too expensive. For this reason the lubricating oil fractions of these oils are vaporized, leaving a heavy flux or asphalt as bottoms. The overhead products yield heavy lubricants of light color and low volatility and of low carbon residue. They are easily acid-treated with 10-20 pounds of sulfuric acid per barrel with a loss of 10-13 percent by volume. Residual stocks from the same crudes require 35-40 pounds of acid per barrel and yield 50-55 percent by volume of treated oil. With similar acid treatment, residual green stocks lose only 25-32 percent of their original volume. These figures refer to acid of 93 percent concentration which was quite satisfactory until the competition from solvent-treated oils forced the refiner to use acid of 98 percent with consequent larger treating losses.

After acid-treating, the residual and the distillate cylinder stocks are blended in a manner that the desired properties of the finished oils are obtained. Previous to the introduction of solvent-treating the public was accustomed to judge the quality of a lubricant by its color; the darker it was, the better was the oil. The refiner had to satisfy this demand by blending the dark residual stocks with light-colored distillates in a ratio of one to one. As the demand for lighter colored oils increased, ever higher percentages of highly acid-treated distillate stocks were used for blends, and means had to be found to overcome the increasing difficulties at the centrifuges caused by blends containing as much as 80 percent of heavy distillate stocks.

Another point to be considered was the viscosity index, a specification easily met by solvent-treating, while the owner of a centrifuge plant could do little about it by acid-treating. He determined the viscosity indices of his different stocks and blended them in a manner which would produce the possible maximum.

In order to adjust the stocks to other demands, such as Conradson carbon residue, the same difficulties were encountered. The ratio of distillate to residual stocks had to be increased in order to lower the carbon residue test. Simultaneously, the demand for products of increased viscosity caused more headaches and reduced the throughput through the dewaxing plant by requiring recycling of part of the charge.

Table B shows the yields of different fractions from a Mid-Continent crude oil when making distillate cylinder stock.

TABLE B

	Percent of Crude	Percent of Reduced Crude
Reduced crude	39.93	100.00
Wax distillate	17.97	45.00
Slop Cut	6.16	15.43
Cylinder stock	9.80	24.56
Flux	6.09	15.02
Loss	0.09	0.01

Properties and 5 mm. Distillation of Overhead Cylinder Stock; Gravity° API, 21.7; Flash 530, S. U. Viscosity at 210-152, Pour 107.

I.B.P. at 5 mm.	538	30%	645
5 percent	577	40%	664
10 percent	595	50%	684 cracking
20 percent	623	....	.....

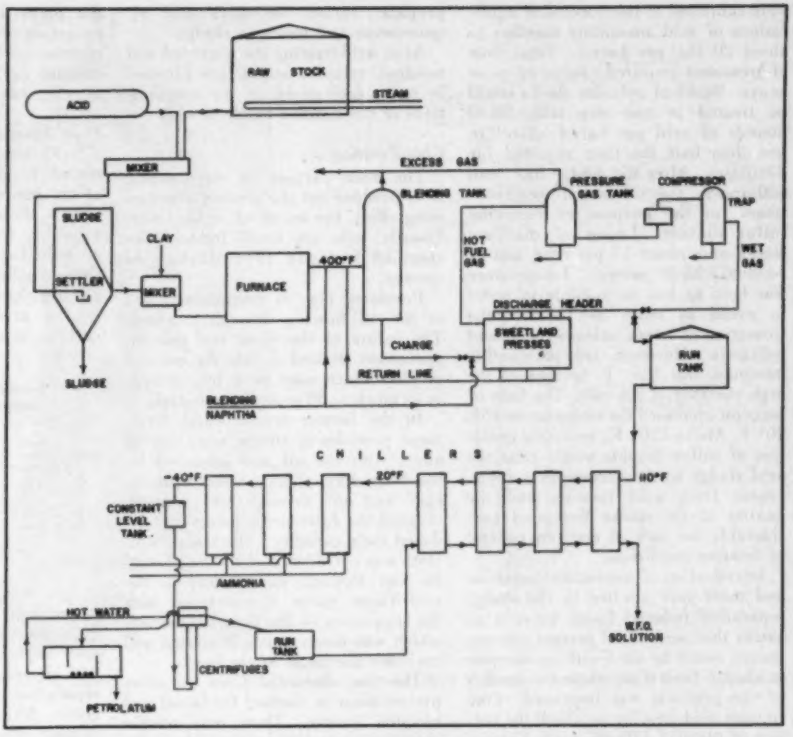
Flux: Gravity °API. 12.7; Flash 670, Melting Point 92.

Plant Operation

The raw stocks are usually acid-treated, although it is possible to make steam-refined cylinder stock from untreated residual material if certain precautions are observed.

Competition from solvent-treated oils forced the centrifuge plant operator to pay more attention to losses. Introduction of continuous acid-treating and dilution of the raw oils with a solvent improved yields a great deal.

After separation of the acid sludge from the oil, the different stocks are blended for the production of specified lubricants. Powdered filter clay is added, the quantities depending on the severity of the previous acid treating. The slurry of oil and clay is pumped through a small pipe still for complete absorption of traces of acid and partial decolorization. Still temperatures vary with the charge and the desired result and may run between 250° and 750° F. From the still the slurry goes to a blending tank where it is mixed in the ratio of one to one with naphtha for the purpose of reducing the temperature and the viscosity before filtration. The clay is usually separated from the oil in Sweetland presses. These consist of a number of leaves covered with metal screens suspended from a common discharge pipe in a shell. The material to be filtered is pumped into the shell, and the liquid part is forced under a pressure of about 50 psig through the filter leaves. When they are covered with a coat of clay as indicated by the cessation of flow of oil from the common header, the slurry remaining in the shell is pumped back to the blending tank. The oil adhering to the clay on the filter leaves is washed out with naphtha, whereupon the filter cake is blown with hot flue gas and the shell is



Continuous Acid Treating and Dewaxing of Heavy Lubricants.

opened for the discharge of the clay. The filtrate is further thinned with naphtha to the gravity required for the production of the desired pour point. Heavy oils may have to be diluted to the ratio of one volume to four volumes of naphtha. Usually, the gravity of the oil solution lies between 42° and 48° API.

The oil-naphtha solution is heated to the temperature at which every trace of wax is dissolved. Chilling is carried out in vertical tanks provided with bundles of chilling pipes. Oil-naphtha solution flows countercurrent to cold dewaxed oil coming from the centrifuges and is thereby cooled to about 20° F. The low temperatures necessary for obtaining the desired pour points is reached by chilling with cold brine or by direct ammonia expansion. For a pour point of 20° F., chilling to —10° to —15° F. is sufficient. If zero pour point oil is made, temperatures as low as —45° F. may have to be reached.

Very slow chilling was formerly considered essential. The reason given was that only by lowering the temperature very gradually, not more than two degrees per hour, could the right crystal size of the perolatum be secured to assure good separation by centrifuging. This rule seems to contradict the demand for a minimum crystal size, as slow chilling causes crystals to grow larger. The cold oil-wax-naphtha slurry flows to a constant level tank, from which it is fed to super-centrifuges. These are vertical cyclinders, called "bowls," about 4½ inches in diameter and 30 inches long. The charge enters at the bottom of the bowl through a nozzle, the opening of which varies from ¼ to ½ inch depending on the speed of flow required for the production of the different pour points. Streamlined flow through the bowl is assured by a three-bladed assembly, called "three wing" which is inserted into the bowl. The bowls rotate at 15,000-17,000 rpm. On its travel up through the bowl, the petrolatum separates into a layer on the wall of the cylinder. A layer of wax-free oil solution is formed in an inner concentric ring. The petrolatum escapes near the top through a weir or ring-dam which is adjusted to the quantity of petrolatum in the charge. Clogging of the weir is prevented by a spray of water heated to about 160° F. which melts the petrolatum. Some of the water penetrates into the bowl, forcing its way between the metal wall and the perolatum and melts the latter. The mixture of viscous oil, wax, and water is separated in a rundown tank, and the water is reheated and recirculated to the centrifuges.

The capacity of a Sharples centrifuge is 25-55 barrels of naphtha-free oil per day, each unit handling 70-240 barrels of the chilled slurry. It varies with the properties of the charge, the dilution of the oil and the pour point desired. These figures do not agree with those found in literature and are taken from the author's personal records. Each machine requires 5-10 tons of refrigeration (one ton equals 12,000 Btu per hour) and is driven by an individual motor of 1 kw.

The naphtha is separated from the wax-free oil by distillation, and the oil is split into lighter and heavier fractions for blending purposes. All products are finally percolated through filter clay and then freed of traces of moisture.

Acid-Treating

The raw stocks were formerly treated with acid of 93 percent concentration in tanks of 1000-2000 barrel capacity. Agitation by compressed air was applied for about one-half hour. The sludge was settled and the oil drawn. Overhead cylinder stocks

were subjected to two successive applications of acid amounting together to about 20 lbs. per barrel. Total time of treatment required twelve or more hours. Residual cylinder stocks could be treated in one step with 30-40 pounds of acid per barrel of oil in less than half the time required for distillates. After the sludge had been withdrawn, the oil was blown with steam for the purpose of removing sulfur dioxide. Losses of distillate stocks were about 13 per cent, and of residuals 25-30 percent. Temperature was held as low as possible in order to avoid as much as possible the formation of esters, sulfonic acids and polymers. However, the permissible minimum was 135° F. because of the high viscosity of the oils. The heat of reaction increased the temperature 15°-20° F. Above 150° F., excessive evolution of sulfur dioxide would raise the acid sludge to the surface as a foam. Losses from acid treating and the quality of the stocks fluctuated considerably for lack of accurate control of treating conditions.

Introduction of mechanical agitation and more care applied to the sludge separation reduced losses to such an extent that acid of 98 percent concentration could be used with no increase in sludge formation while the quality of the products was improved. Continuous acid treating in which the contact of the acid with the oil is reduced to one minute or less, and severe mechanical agitation followed by continuous automatic sludge separation caused a decrease in acid consumption of as much as 20 percent and in sludge formation of 25 percent.[4] Treating in naphtha solution, or still better in propane, further decreases acid requirements and losses to sludge.[5]

After acid-treating the overhead and residual cylinder stocks are blended in ratios determined by the specifications of the finished bright stocks.

Clay-Treating

The main purpose of clay-treating is to produce not the greatest decolorizing effect, but an oil of stable color. Usually, oils are made lighter than specified because they darken in storage.

Powdered clay is continuously fed to the oil flowing through a mixer. The nature of the stock and the improvement desired dictate the amount of clay which may be a few pounds or as much as 50 pounds per barrel.

In the former erratic batch treatment, particles of sludge were carried along with the oil and adsorbed by the filter clay. They passed with the clay and oil through the furnace, clogged the filter press leaves and reduced their capacity. The metal filter cloth was corroded, and the clay found its way through the chillers to the centrifuges where it interfered with the separation of the petrolatum, and, which was much worse, it eroded and corroded the metal of the bowls.

The clay discarded from the filter presses must be checked for its oil and naphtha content. There may remain as much as ten percent oil in the clay if the time for naphtha-washing and drying with flue gas is cut short. These losses can be reduced to one-third by good supervision and may save thousands of barrels of bright stock annually.

The dilution of the oil with naphtha plays an important part in the operation of the filter presses. Blends containing less than one volume of naphtha per volume of oil reduce the filtering rate.

Final Blending with Naphtha

Sufficient solvent must be added to the oil to give a non-viscous solution at low temperatures. A naphtha fraction is chosen which has a minimum solubility for wax at the temperature of centrifuging. Weber and Dunlap[6] showed solubilities of paraffin wax of 132.8 at melting point and a specific gravity at 69° F. in various hydrocarbons as set forth in Table C.

TABLE C

Solubility of Paraffin Wax
Grams per 100 ml. Solvent

Temp.	n-pentane	n-hexane	n-heptane	n-Octane	Iso decane
32	....	2.77	1.37	0.99	....
41	....	3.69	2.18	1.69	0.94
50	5.11	4.81	3.55	2.90	1.44
59	6.94	6.07	5.06	4.24	2.74
68	9.53	8.31	7.18	5.93	4.96
77	17.16	16.23	14.36	11.66	9.17

As a wax solvent, heavy naphtha is better than lighter distillates. However, the viscosity of mixtures of oil and naphtha increases considerably with decreasing temperatures, and the separation in the centrifuges may become difficult. Bahlke, Giles, and Adams[7] determined the specific gravities and viscosities of naphtha solutions of an SAE 50 distillate oil at —10° F. and reported the results as shown in Table D.

TABLE D

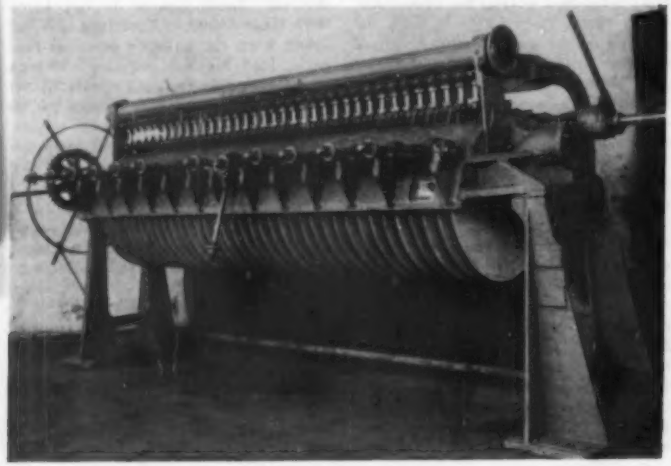
Percent Oil	Percent Solvent	Specific Gravity: Naphtha Solvent	Specific Gravity: Butane Solvent	Viscosity, Poises: Naphtha Solvent	Viscosity, Poises: Butane Solvent
15	85	0.813	0.667	0.025	0.005
25	75	0.828	0.700	0.047	0.009
35	65	0.841	0.733	0.101	0.018

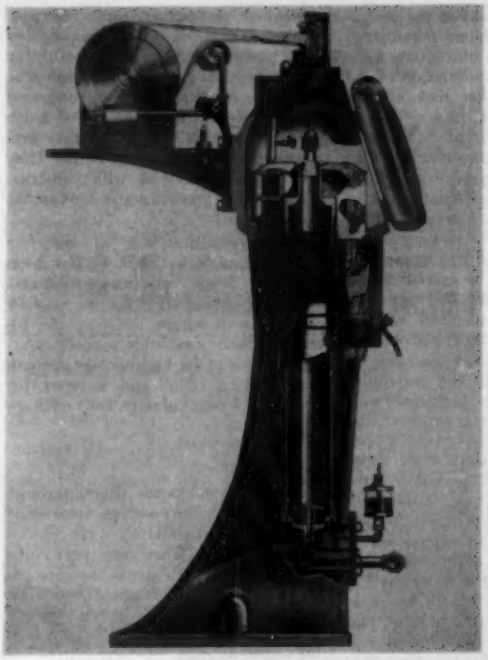
Increase in the oil content of the solution from 15 to 35 percent increased the viscosity in naphtha solution four-fold and in butane solution more than three-fold.

Waxes are most soluble in hydrocarbons of a molecular weight from 60-120 (butane to octane) with peak solubilities at a molecular weight of about 90. For the sake of safety, low boiling hydrocarbons cannot be used in a centrifuge plant. Most suitable as a solvent would be hydrocarbons of a high content in decane (molecular weight 142) and of an average boiling point of 345° F. In actual plant practice, naphthas of a boiling range from 200°-400° F. are common; they have an API gravity of around 56°.

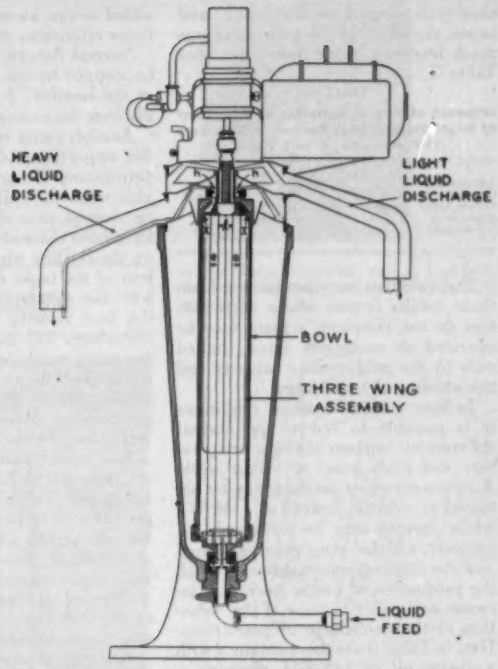
Since naphtha has an appreciable solvent power for wax at low tempera-

Sweetland Press (Open.) Courtesy, Oliver United Filters, Inc.





Cross Section of Presurtite Supercentrifuge.



Supercentrifuge. (Both illustrations courtesy, The Sharples Corporation.)

ture, the pour point of a dewaxed oil will be about two degrees above that of the dewaxed oil-naphtha solution. Upon evaporation the naphtha leaves the wax that was dissolved in it with the dewaxed solvent-free oil.

The gravity of the solution charged to the centrifuges is dictated by the desired pour point. Naturally, heavier solutions contain more oil than lighter ones, and the yield of wax-free oil from the former is greater as shown by the record of plant runs shown in Table E.

TABLE E

Influence of Gravity of Charge Solution on the Pour Point and Production of Oil—Centrifuging at —46° F.

Gravity °API	Daily WFO per Machine Barrel	Percent Petrolatum	WFO Percent of Charge	Pour Point
47.2	30.1	14.1	23.2	0
46	30.5	13.9	23.4	2.1
45	29.8	21.1	28.3	2.1
44	43.2	16.0	31.4	7.9
43	47.2	13.8	33.0	13.8

Rate of Chilling and Agitation

The reason given for the recommending of slow chilling has been stated. In order to discover whether this contention had any factual basis, a series of tests was conducted in a five-barrel pilot plant permitting different chilling rates. The charge was an acid and No. 1 clay-treated cylinder stock blend diluted with naphtha to 46° API gravity. In one run the temperature was reduced at the usual rate of six degrees per hour from 110° to —46° F. in 26 hours, while in the other test chilling was as rapid as the equipment would permit. In the latter case, the temperature drop in the first hour was 88° F., and in the second hour 32° F. It required, however, five hours to reach —46° F. The results are shown in Table F.

TABLE F

	Gravity °API.	Pour Point Wax-Free Oil	Tag-Rob. Color	Percent Net Petrolatum
Chilling 6 deg/hr.	46.1	—4	1¼	21.5
Chilling Fast	46.2	—3	1½	20.9

Pour points were very closely the same; color was better, and petrolatum was somewhat less in fast chilling than in slow chilling. It may be stated that the two tests produced identical results.

Agitation

Usually, when a plant is idle on account of repairs, agitation in the chilling tanks continues at constant temperatures in order to prevent settling of the petrolatum. If given enough time, the wax already in crystallized form goes into colloidal solution, and the contents of the tanks are converted into a fairly stiff transparent jelly. Separation of petrolatum by centrifuging is impossible. After long standing at the crystallizing temperature of the wax, a precipitate of ceresin is formed. In order to determine the influence of agitation on the pour point the following tests were conducted in the five-barrel pilot plant. In one series, the rate of chilling was held constant at 6° F. an hour, and agitation was changed for each run. Normally, the stirrer made 29 rpm. The influence of excessive agitation is evident. On doubling the number of revolutions of the stirrer, the pour point increased from —4 to +2, and with three and one-half normal agitation, it rose to +43. See Table F.

TABLE F

Influence of Rate of Agitation on Pour Point of Bright Stock at Normal Rate of Chilling from 110° to —46° F. in 26 Hours.

Agitation-RPM	106	90	29	13	6
Gravity °API	46.3	46.4	46.1	46.0	46.6
Centrif. Temp.	—45	—46	—45	—45	—46
Bright Stock Pour Point	43	2	—4	—4	—3

In a second series of tests, chilling was as rapid as possible, and agitation was changed for each run. Agitation

time was reduced to five hours, and hence, the effect on the pour point was much less than in the first series. See Table G.

TABLE G

Influence of Rate of Agitation on Pour Point of Bright Stock at High Rate of Chilling from 110° to —46° F. in 5 Hours.

Agitation-RPM	106	60	29	13	8
Gravity °API	46.0	45.9	46.2	46.3	46.3
Centrif. Temp.	—45	—46	—45	—46	—46
Bright Stock Pour Point	6	—2	—3	—4	—4

The rule that may be derived from these results is that where other factors do not interfere, a plant may be operated at maximum speed limited only by the refrigerating capacity and the number of centrifuges.

In long runs at constant conditions it is possible to reduce the normal differential between chilling temperature and pour point of bright stock. A zero pour point product may be obtained at —38° F. instead of —45° F., while thruput may be increased. If, however, a higher pour point is desired and the chilling temperature is raised, the production of bright stock may increase noticeably because of the reduction in the percentage of petrolatum. Data in Table H are those obtained with a charge oil of 140 S.U. viscosity at 210° F. diluted to 46° API gravity. Nothing was changed except the chilling temperature.

TABLE H

Chilling Temp. °F.	Pour Point °F.	Petrolatum Percent	Barrels of Solution per Machine Day
—34	6.4	12.9	156.7
—37.5	3.5	12.3	158.0
—42.2	—0.4	11.5	159.9

Centrifuges

The feed to the centrifuges depends on the size of the inlet nozzles and on the pressure on the charge coming from the header. Even distribution to all machines is attained by means of flow controllers. Separation of the petrolatum is regulated at the outlet weirs.

If the petrolatum is free of hard paraffin wax crystals, the centrifuge bowls remain almost free of deposits and may require cleaning once every 48 hours. Presence of small amounts of hard wax may raise the pour point 20° F., and large quantities may fill the bowls completely in half an hour.

Dewaxing of untreated cylinder stocks for the production of steam-refined lubricants may be accompanied by troubles arising from the asphaltic matter which flows with difficulty through the centrifuges, and from the emulsification of the petrolatum. A very small amount of demulsifier added to the water used at the centrifuges eliminates the latter possibility.

Normal flow to the centrifuges may be stopped by the accumulation of ice at the nozzles. It takes ingenuity to discover the cources of the ice.

Another cause of trouble is the sudden appearance of large quantities of petrolatum. These masses are noticeable when the chilling tanks ought to be cleaned or a short time after they have been cleaned. The wax deposited on the chilling pipes drops to the bottom of the tanks and is carried along with the stream. When this happens, the best remedy is to flush all the centrifuges with hot water, a procedure requiring much less time than the removal and cleaning of the individual bowls. Much of this disturbance is prevented by frequent removal of the wax from the chilling pipes.

Insufficient water spray at the weirs of the bowls will not melt the petrolatum and cause plugging. If this happens, the petrolatum escapes through the oil outlet, and no separation is obtained. A leak of ammonia from the compressors into the water used at the centrifuges may loosen the scale in the water pipes, prevent flow and stop the functioning of the machines.

It is easy to observe the performance of each centrifuge by the appearance of the wax-free solution. If the stream becomes turbid with petrolatum, it should be diverted to a slop line for recirculation.

The centrifuges must be carefully inspected for the slightest defects. Rupture of a bowl is very hazardous to the operators. Best practice is to replace all bowls once a year regardless of their apparent state of preservation.

Petrolatum

Petrolatum, when separated from the water, consists of wax and oil and some coloring and resinous matter. It may amount to ten per cent for Mid-Continent oils and to as much as 50 percent or more when trouble occurs. The water-free petrolatum is a light-brown soft mass; if contaminated with clay from the presses, it has a greenish tint. The oil content of the petrolatum depends on the effectiveness of the operation and on the products desired. Table I shows a few examples of petrolatums obtained at different operating conditions.

TABLE I

Naphtha Percent	Oil Percent	Wax Percent	Melting Point
30.7	26.0	43.3	153
38.2	30.8	31.0	153
48.7	31.9	19.4	152
68.0	30.0	2.0	124

* * *

Refined petrolatum serves as protective ointment. When emulsified with higher alcohols it is useful for pharmaceutical purposes. Considerable quantities of petrolatum are consumed in the preparation of so-called slush greases, which are soft, temporary protective coatings for metal parts. They are readily removed with naphtha. Much of the petrolatum is sent to the cracking stills.

Microcrystalline wax of melting points as high as 180° F. has been prepared from certain petrolatums. The oil is separated from the wax by dissolving in butane, chilling and filtering. Such wax finds a ready market because of its high tensile strength and melting point and is used for wrappers, particularly for military equipment.

Bright Stocks

All bright stocks are filtered through clay for the purpose of improving fluorescence stability, color, and emulsion test. They are percolated above 200° F. in tanks holding as many as 50 tons of granulated clay. The spent clay is air-blown, washed with naptha and steamed before it is regenerated.

Supervision

There are so many possibilities of losses that supervision must be on the alert. Although improvements in acid-treating have eliminated much grief, large quantities of oil and naphtha may be thrown away at the filter presses and at the percolators with badly washed clay. The impossible can be expected. Water-draw valves are left open, tanks overflow, valves leak. Gravity, oil and naphtha content of material found in the slush pond and the water cooling pond permit to trace it to its origin. In partly open systems, naphtha losses may grow to such proportions that half a barrel of naphtha may disappear for each barrel of finished bright stock. Low initial boiling points may cause a loss of ten percent. Naphtha vapors blown from filter presses, from the blending tank and from the percolators should be condensed.

End of Part II and series.

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[4] J. D. Morgan, Oil Gas J., Oct. 14, 1948, p. 87.
[5] Jacobi and McMakin, Oil Gas J., April 1, 1948, p. 169; McCluer, Dickinson and Forrest, Oil Gas J., Oct. 27, 1938, p. 174, Nov. 18, 1938, p. 209; Bahlke, Thiele, Adams and Ginsberg, Oil Gas J., July 22, 1937, p. 44.
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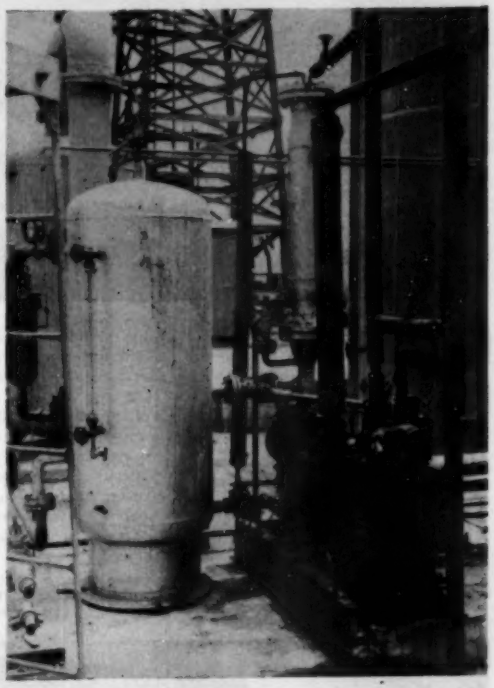
MAINTENANCE And OPERATION How To Do It—

Pulsation Dampener for Pumping Gasoline

IN a natural gasoline plant where the wild gasoline is transferred by a reciprocating steam pump, pulsation has been eliminated by a dual installation of surge vessels. The first vessel serves as a gas chamber and is mounted on top of the pump liquid chamber. This vessel was fashioned from pipe, using a flanged swedge at the bottom and a companion flange at the top. The second vessel, set at the side of the pump, is a conventional high-pressure accumulator drum connected in series with the first vessel. The connection is made from the base of the first vessel to a nozzle located at the vertical mid-point of the second vessel. The accumulator vessel is equipped with a liquid level controller, which maintains a void of one-third the vessel capacity. Pulsations are absorbed by the gas-filled void, providing steady conditions for the subsequent metering of the gasoline flow. Both vessels are equipped with relief valves to relieve gas and gasoline when the pumping pressure becomes excessive.



Vertical Belt Drives Operated Without Slip

VERTICAL belt drives without the need of a wrapper pulley may be arranged to operate without slip, as shown in Figures 1, 2, and 3. Figure 1 shows how to do it when the pulleys are of the same size; Figure 2 illustrates the case where the top pulley is larger than the bottom pulley; and Figure 3 is for the case where the top pulley is smaller than the bottom pulley.

In each case the tight side is at the bottom and the angle of the slack side with the vertical is 5 to 10 degrees. If the drive fluctuates, the angle with the vertical must be greater than 10 degrees. For extreme cases of fluctuation, wrapper or tension devices must be used.

The satisfactory operation of vertical drives necessitates the following considerations: 1) Use high quality, high friction belts; 2) Use two-ply leather belting rather than single-ply as double belting is less likely to stretch; and 3) Use belting of ample width and pulleys of ample diameter.

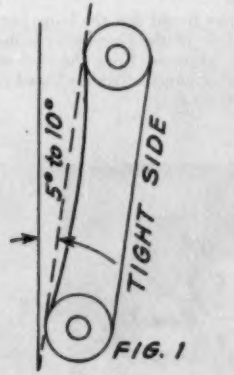


FIG. 1

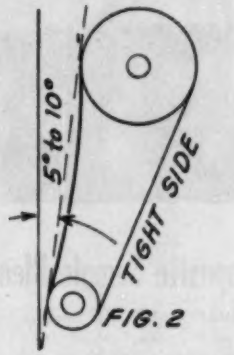


FIG. 2

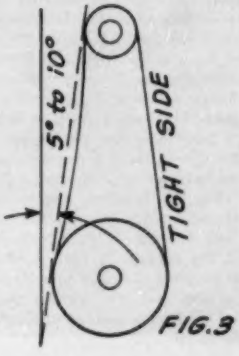
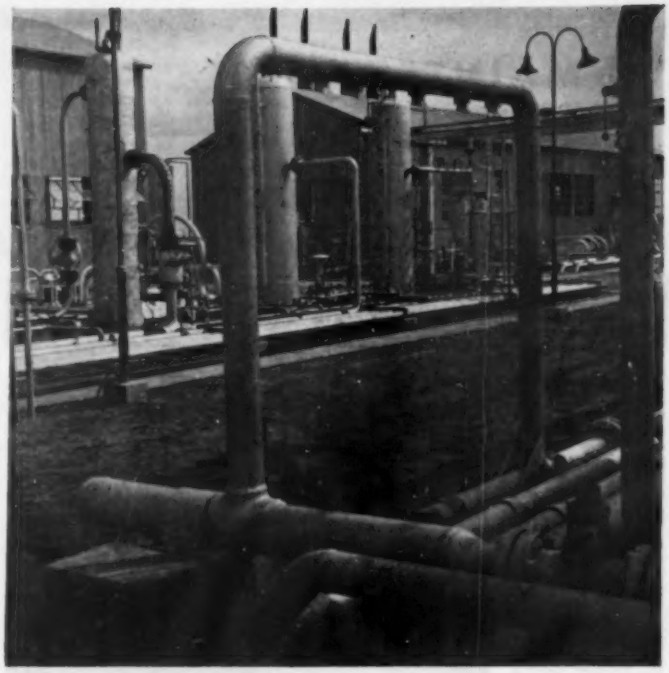


FIG. 3

Loop Dampens Pulsations

THE design of the piping system shown in the accompanying photograph did not originally include the loop. Severe pulsations encountered in the early operation of the plant threatened damage to the line, a discharge conduit from a high pressure lean oil pump.

It was found that the loop, installed as a side of the line outlet some distance upstream from the end of the pipe run, effectively suppressed the severe vibrations.



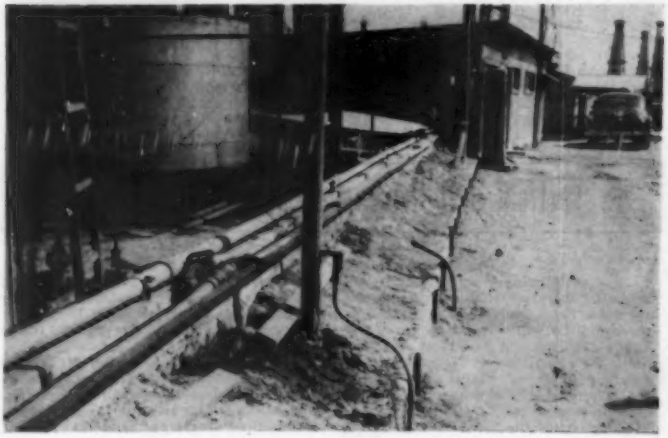
Composite Sample Blender

COMPOSITE tank samples of top, middle, and bottom strata can be conveniently blended by the rocker-type apparatus illustrated. The blender vessel is a sheet metal cylinder with two openings at one end for filling and sampling. The filler opening is fitted with a two-inch flange which is closed with a cast iron plug. The sample opening is fitted with a gate valve and pipe spout. The cylinder is supported with trunnions set in open bearings on a light steel framework. For the blending operation, the samples are poured into the filler opening; and after the plug has been replaced, the cylinder is rocked by hand for the required period of time. Mounted over a slop can, the cylinder may be drained of excess sample through the sample spout.

Fire Hose Trough Provides Protection And Ready Service

HOSE protection and instant fire protection has been accomplished by one tank farm by the installation of fire hose in a steel trough along the firewall. The troughs are of lightweight channel iron welded into a long section for the full length of the hose. The hose is connected permanently to hydrants and the slope of the trough is such that the hose will drain automatically. Covers of similar material in six-foot sections are laid end to end above the hose for protection against sunlight and rainfall. In pulling the hose nozzle to the point of fire fighting, the operator is not hampered by the covers since they fall to the side at random.

Shown below is the trough along the firewall with one section of the fire hose exposed and one section covered.

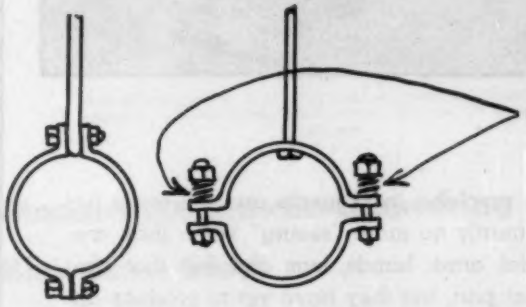


Cover Plate for Compressor Inspection

A COVER plate that permits visual inspection of the compressor crosshead, rod and packing and at the same time provides additional crankcase ventilation, can be made from fine mesh screen and a light metal frame.

The frame is made in two sections joined with piano hinges. The upper section, secured to the engine with cap screws, simply holds the inspection plate in place. The lower hinged section, made from light metal strap to which a fine mesh screen is soldered lays flat against the machined inspection plate seat with no fastenings. Thus it can be instantly opened when the operator desires to inspect the packing rods or crossheads. This is of particular advantage during the period immediately following the installation of a new piston rod, when overheating is likely.

The fine mesh screen provides for additional crankcase breathing during engine operation.



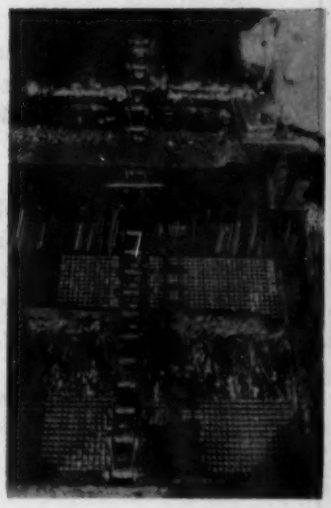
Flexible Pipe Hangers Prevent Fractures

IF YOU'RE bothered by leaks in steam lines resulting from too rigid a support, an easy soluton to ithe problem may be effected by the use of compression springs with the existing pipe hangers. Supporting steam lines from an I-beam with conventional pipe hangers often results in fractures when the steam pipe expands, due to the rigidity of the support. By rotating the existing straps 90 degrees, the vertical rod of the hanger may be attached as shown in the sketch. Flexibility in the support is accomplished by the use of compression springs at the bolted strap connections.

Waste Oil Cleaning System Divised

REMOVING foreign matter from waste oil being transferred from a slop tank or skimmer pit may be accomplished by means of screens which are continuously wiped by revolving brushes. The separating screens may be installed in the transfer line from the sump pump to the salvaged oil tanks. Conventional fiber brushes used for sweeping floors are enclosed in cases having the width of the broom brush. The screen cases are installed at an angle above a rectangular tank through which the oil flows. The fiber brushes are mounted with flexible cleats to endless chains, driven by a small electric motor.

As the brushes approach the low end of the screens, they turn down and drag along the screen to wipe foreign matter upward to a waste receiver at the rear of the rectangular tank. The resulting oil is relatively free of debris.



"Operation Safety"

W. A. SULLENDER
Pan American Refining Corporation, Texas City, Texas

PROTECT YOUR EYES!

Your eyes are your most delicate precision instruments and there are no spares, no substitutes, and consequently no more "seeing" when they are gone. Scientists have devised artificial arms, hands, legs and feet that can serve some of the functions of the lost part, but they have yet to produce an artificial eye with which you can see. You will be well advised to continue to **WEAR YOUR GOGGLES** because it is unlikely that such an eye will ever be produced.

Various functions of certain parts of the eye are still a subject of study by the medical profession. It may be of dubious comfort for those who do not wear their goggles to know that eye surgery has made remarkable progress in the past several years and, in some instances, they can get relief in a gruesome sort of way.

Witless Willie, shown disregarding two safety practices simultaneously, is now at home demanding that the insurance company print his checks in braille!

The 150-foot blowdown stack shown in the photograph at left recently was placed in operation at the Oleum refinery of Union Oil Company of California.

Modern Automatic-Quenching Blowdown Stack Erected at Oleum Refinery

JOHN C. ALBRIGHT
Santa Monica, Calif.

UNION Oil Company of California, recently has placed a completely modern, automatic-quenching blowdown stack in operation at its Oleum refinery. The blowdown stack was designed and built to handle all furnace effluence at periodic or emergency blowdowns not only of five separate units, but the relief stack vapors from two additional units. The stack was located at one side of the main road inside the refinery and is easily approached for maintenance and manual operation and inspection.

A concrete foundation slab was poured, having a surface area 30 feet square, into an excavation five feet deep. This required approximately 170 cubic yards of concrete. The 30-foot-square area was inclosed with a fire-wall approximately five feet in height to prevent spilling of liquids which might escape due to line breakage.

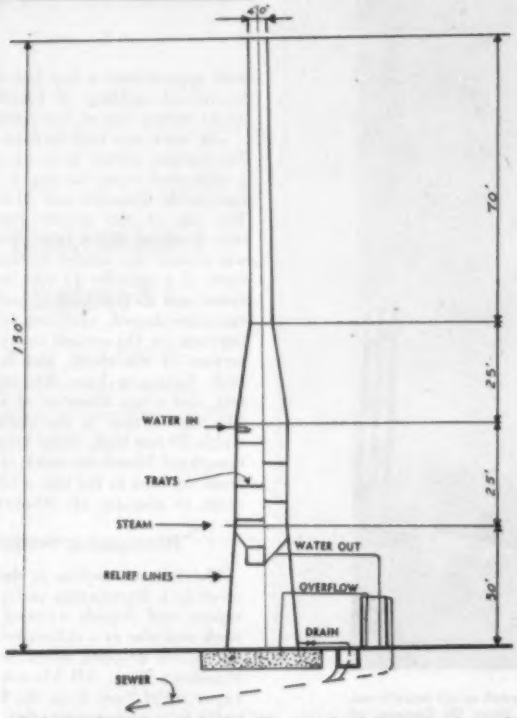
The stack was built in four sections. The bottom section is in the shape of a truncated cone, having a base 18 feet inside diameter and 30 feet high. The top of the section has an inside diameter of 11 feet, upon which was placed the second section, in the form of a cylinder 11 feet inside diameter and 25 feet high. Another truncate-cone-shaped section is superimposed on the second or cylindrical section of the stack, and is 25 feet high, having a base diameter of 11 feet, and a top diameter of four feet. The top section is the stack proper and is 70 feet high. Total height of the completed blowdown stack is 150 feet from the base to the top, a height adequate to disperse all refinery vapors.

Disengaging Section

The bottom section is designed to serve as a disengaging section for all vapors and liquids vented into the stack and also as a collective space for all liquids dropped down through the blowdown lines. All blowdown and vapor relief lines from the individual refinery units enter this section through a common header attached to flanged nozzle. The nozzle, fastened onto the shell of the base section at an angle, creates a violent whirling motion of the vapors and liquids so as to accelerate separation.

Five Shower Trays

The cylindrical section, (11 feet i.d. by 25 feet high) contains five shower trays over which water spills for quenching high temperature vapors and condensing any hydrocarbons which might escape through the stack from the blowdown material. The shower trays are side-to-side pans with shallow wiers over which the water as it travels along maintains a wall through which the vapors must pass in sequence from the base section. Adequate water supply comes through a six-inch line. The water line is equipped with a thermostatically controlled valve to open automatically when the temperature of any material entering the stack is as high as 250° F. The control bulb is placed in the inlet header carrying the blowdown material and is set so that the valve will trip on contact with hot oil, but



Above—Sketch showing Dimensions of Modern Blowdown Stack Erected by Union Oil Company of California at Its Oleum Plant.
Below—Blowdown and Relief Vapor Lines Converging on the Blowdown Stack and Carried on Trestles to the Base of the Unit.

not on contact with steam introduced into the unit.

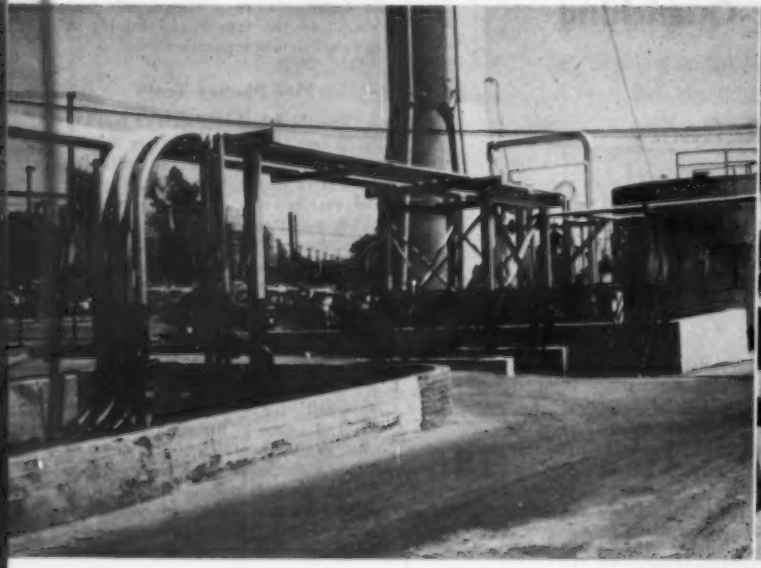
The quench water enters the stack at the top of the cylindrical section and spills upon a narrow tray which acts as a spreader. Water passing from the bottom shower tray must fall on a collecting pan so it will drain through a 12-inch withdrawal line. Because of the collecting pan, water cannot pass into the cone-shaped bottom section and come in contact with hot oil.

Sump Above Ground

The withdrawal line travels away from the stack several feet where it drops vertically into a water-sealed sump. This sump is above ground and contains a dividing wall to separate water from any oil accompanying the water. But free water flows into the refinery waste water disposal system leading to water-conditioning equipment.

The base of the stack is also equipped with a siphon overflow line to remove excess liquids in an emergency, but is not used for routine removal of compartment liquids. A simplex steam pump is set near the base of the stack to remove oil from the sump section of the stack, and is

Below (section of picture shows on page opposite)—Simplex Steam Pump at the Base of the Unit by which Petroleum Residues are Pumped to Slops for Future Processing and Recovery.

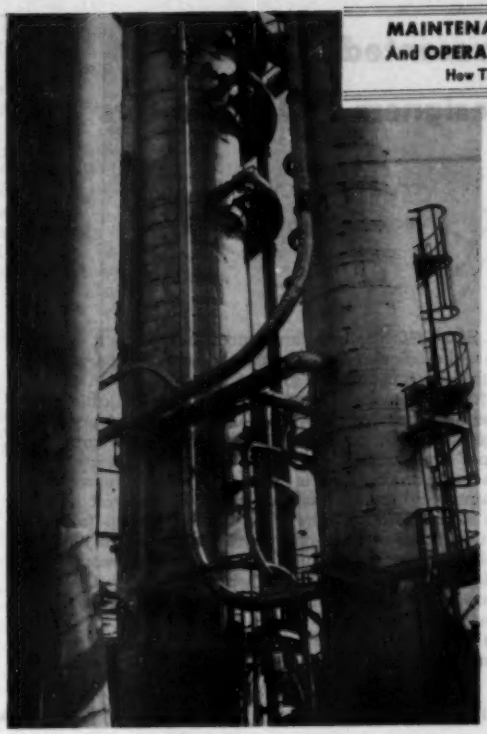


operated by manual starting and liquid-level control during the blowdown cycle.

Steam is admitted to the stack at two separate points. One line carrying high-pressure steam has its inlet above the shower trays and operates as an aspirator to force vapors outward from the top of the stack. The other line is connected to the stack at the base of the cylindrical section containing the shower trays. It supplies purge steam to assist in disengaging vapors from the blowdown oil. The high-pressure steam is used only during a blowdown, but low-pressure steam flows through the stack continuously to prevent accumulation of vapors and to keep the stack in operating condition for instant use.

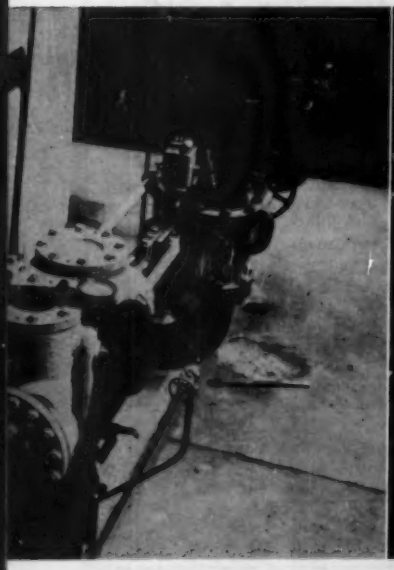
Facilities for Manual Tripping

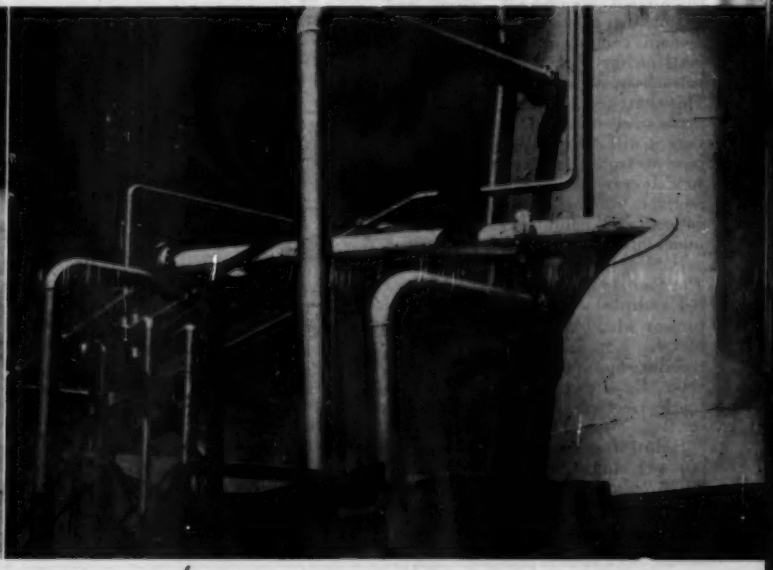
The thermostatically controlled water inlet valve also has facilities for manual tripping so that water may be flushed through the system as a means of removing sediment. When a planned shutdown is imminent, the water valve is tripped from a switch located on the control board so that quench water will start flowing before hot oil reaches the disengaging section in the base of the stack.



Above—Blowdown and Relief Vapor Lines Leading from One of the Major Units with Long Easy Bends Straightening Out to Horizontal.

Below (right)—Diagonal Nozzle Attached to the Shell of the Blowdown Stack through which All Liquids and Vapors are Passed Originating at the Various Processing Units Served by the Blowdown Stack.





CHARTS Presented to Aid Refinery Designers and Operators

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Mechanical Engineer,
New York

GRAPHICAL SOLUTIONS save time and labor when it is necessary to make calculations in refinery design or operation. Although the accuracy of a given chart depends on a number of factors, results obtained by use of suitable charts are generally satisfactory for usual design and operating calculations. Of course, where exact results are desired, proper equations should be used instead of charts.

The five accompanying charts give solutions to many problems commonly met in refinery and petrochemical plant design and operation. They have been set up for easy, quick use. Basis of each chart and limitations in its use are explained. By using these charts in their work, refinery designers and operators will learn how easy it is to get answers to problems without reference to a number of handbooks.

Chart 1 is shown on this page with four more on the pages that follow.

CHART 1

Figuring Air-Receiver Pump-Up Time

Compressed-air usage is extensive in modern refineries and petrochemical plants. Many jobs formerly done by other means are today performed by compressed air quickly, surely and without dirt or waste. Familiarity with modern compressed-air systems is a *must* on the part of all refinery and petrochemical designers and operators. This chart simplifies calculations often made when it is desired to know how long it will take to "pump up" an air receiver from a lower to a higher pressure. It correlates piston displacement, receiver volume, difference between cut-out and cut-in pressures, and pump-up time. Knowing any three variables, the fourth is readily found. The chart is used as follows:

Example: A reciprocating compressor with a 200-cubic-feet-per-minute displacement and 300-cubic-foot receiver supplies air to a refinery pipe shop. How long will it take to pump up the receiver if the "cut-in" pressure is 70 psi, "cut-out" pressure 100 psi?

Solution: Difference between cut-out and cut-in pressures is 100—70 or 30 psi. Enter the chart at the left and draw a straight line from 200 cfm on the displacement scale to 300 cubic feet on the receiver volume scale. Then, from 30 psi on the cut-out minus cut-in pressure scale, draw a straight line through the intersection of the first line with the pivot line. Continue this straight line until it intersects the time scale at the top of the chart and read 3.9 minutes, pump-up time. By entering the chart with any other three variables and solving in a similar manner the fourth variable can be found.

This chart is based on the relation

$$T = \frac{V\,(\Delta P)}{14.7DE}$$

where T = pump-up time, minutes
V = receiver volume, cubic feet
ΔP = cut-out minus cut-in pressure, psi
D = piston displacement, cubic feet per minute
E = volumetric efficiency, expressed as a decimal

The value 14.7 in the denominator is atmospheric pressure at sea level, psi. Hence, the chart is based on performance of a compressor at, or very close to, sea level. For compressors located considerably above sea level, the equation should be used. However, since most refineries and petrochemical plants are located at or about sea level, the chart is valid for them.

Chart 1

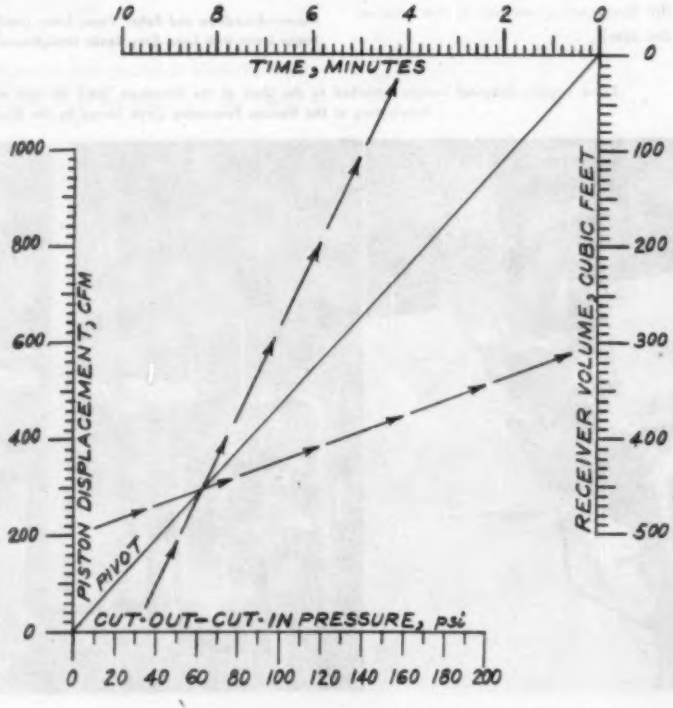
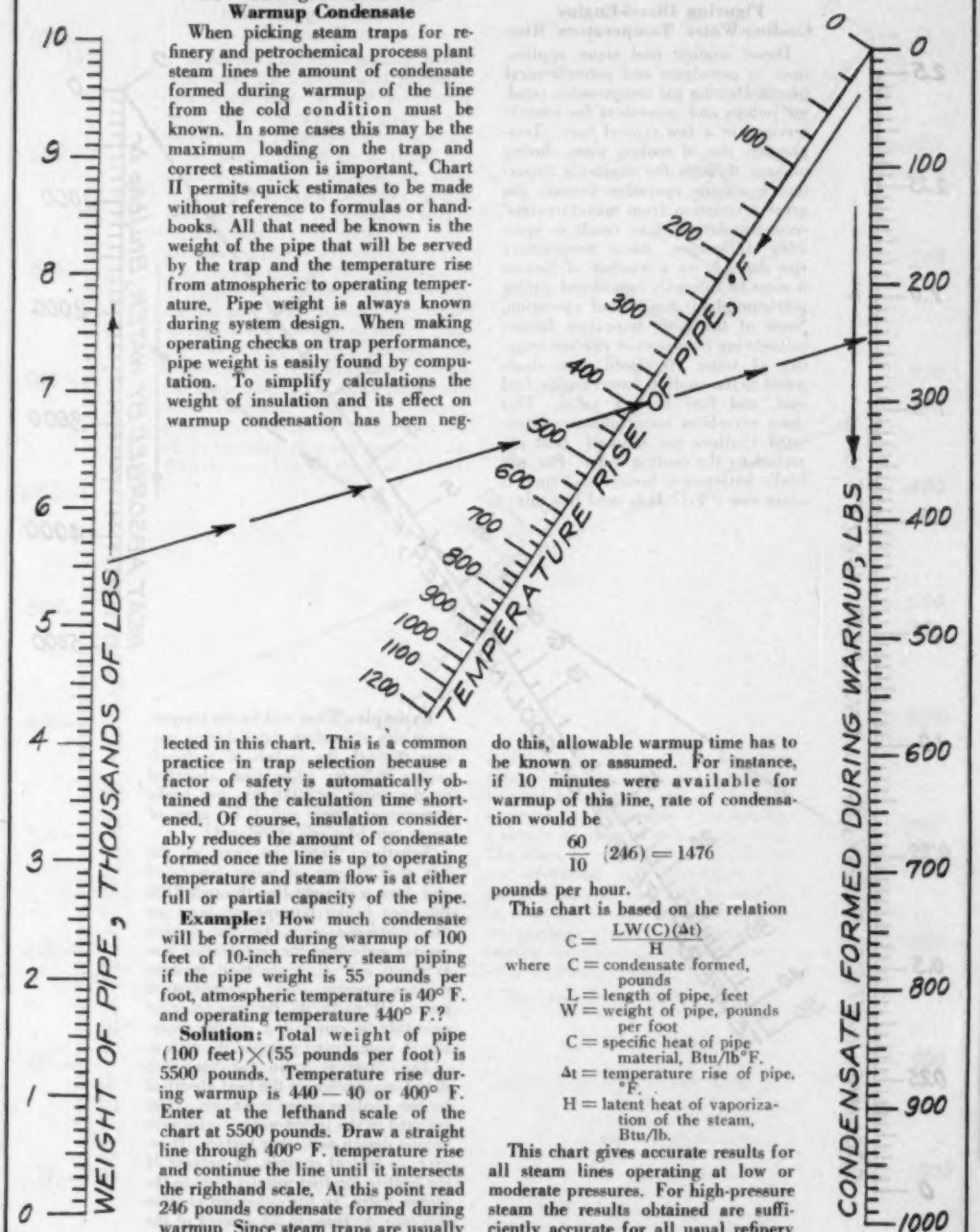


CHART II
How To Figure Steam-Line Warmup Condensate

When picking steam traps for refinery and petrochemical process plant steam lines the amount of condensate formed during warmup of the line from the cold condition must be known. In some cases this may be the maximum loading on the trap and correct estimation is important. Chart II permits quick estimates to be made without reference to formulas or handbooks. All that need be known is the weight of the pipe that will be served by the trap and the temperature rise from atmospheric to operating temperature. Pipe weight is always known during system design. When making operating checks on trap performance, pipe weight is easily found by computation. To simplify calculations the weight of insulation and its effect on warmup condensation has been neglected in this chart. This is a common practice in trap selection because a factor of safety is automatically obtained and the calculation time shortened. Of course, insulation considerably reduces the amount of condensate formed once the line is up to operating temperature and steam flow is at either full or partial capacity of the pipe.



Example: How much condensate will be formed during warmup of 100 feet of 10-inch refinery steam piping if the pipe weight is 55 pounds per foot, atmospheric temperature is 40° F. and operating temperature 440° F.?

Solution: Total weight of pipe (100 feet) × (55 pounds per foot) is 5500 pounds. Temperature rise during warmup is 440 — 40 or 400° F. Enter at the lefthand scale of the chart at 5500 pounds. Draw a straight line through 400° F. temperature rise and continue the line until it intersects the righthand scale. At this point read 246 pounds condensate formed during warmup. Since steam traps are usually rated in pounds per hour of condensate, the value found from the chart must be converted to these units. To do this, allowable warmup time has to be known or assumed. For instance, if 10 minutes were available for warmup of this line, rate of condensation would be

$$\frac{60}{10}\ (246) = 1476$$

pounds per hour.

This chart is based on the relation

$$C = \frac{LW(C)(\Delta t)}{H}$$

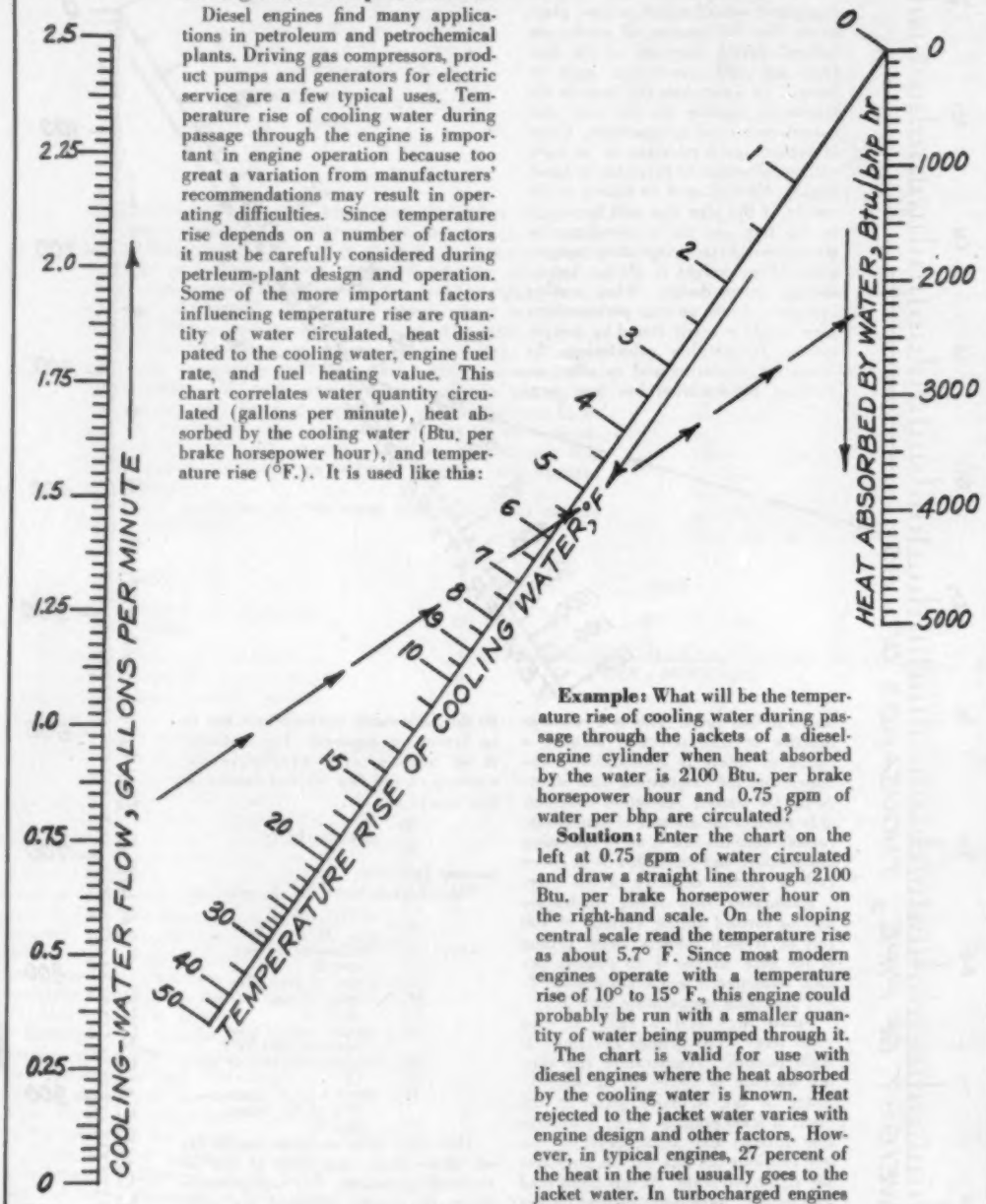
where C = condensate formed, pounds
L = length of pipe, feet
W = weight of pipe, pounds per foot
C = specific heat of pipe material, Btu/lb°F.
Δt = temperature rise of pipe, °F.
H = latent heat of vaporization of the steam, Btu/lb.

This chart gives accurate results for all steam lines operating at low or moderate pressures. For high-pressure steam the results obtained are sufficiently accurate for all usual refinery estimating and operating checks. All results are on the safe side. Use only for steel pipe.

CHART III

Figuring Diesel-Engine Cooling-Water Temperature Rise

Diesel engines find many applications in petroleum and petrochemical plants. Driving gas compressors, product pumps and generators for electric service are a few typical uses. Temperature rise of cooling water during passage through the engine is important in engine operation because too great a variation from manufacturers' recommendations may result in operating difficulties. Since temperature rise depends on a number of factors it must be carefully considered during petrleum-plant design and operation. Some of the more important factors influencing temperature rise are quantity of water circulated, heat dissipated to the cooling water, engine fuel rate, and fuel heating value. This chart correlates water quantity circulated (gallons per minute), heat absorbed by the cooling water (Btu. per brake horsepower hour), and temperature rise (°F.). It is used like this:



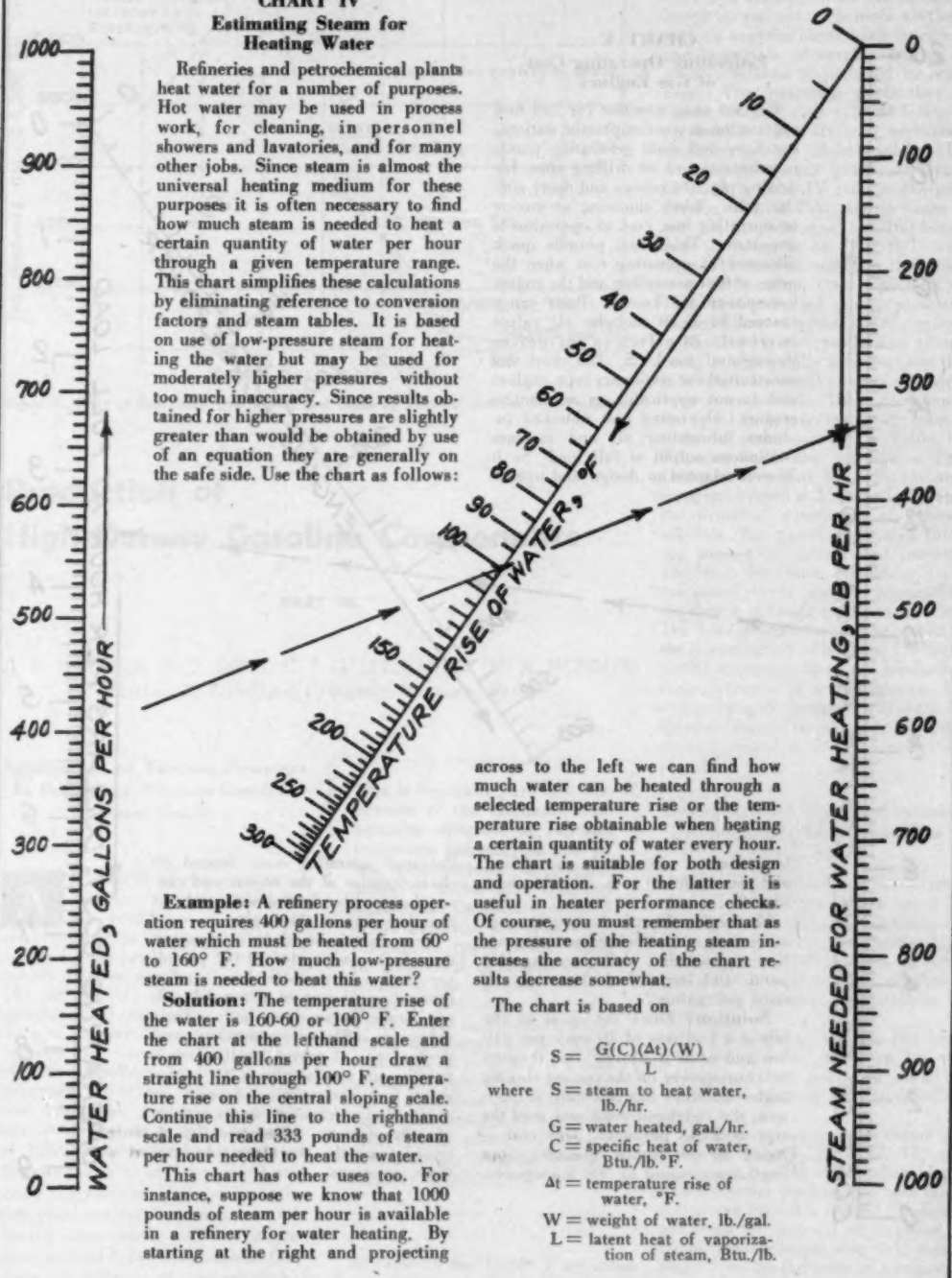
Example: What will be the temperature rise of cooling water during passage through the jackets of a diesel-engine cylinder when heat absorbed by the water is 2100 Btu. per brake horsepower hour and 0.75 gpm of water per bhp are circulated?

Solution: Enter the chart on the left at 0.75 gpm of water circulated and draw a straight line through 2100 Btu. per brake horsepower hour on the right-hand scale. On the sloping central scale read the temperature rise as about 5.7° F. Since most modern engines operate with a temperature rise of 10° to 15° F., this engine could probably be run with a smaller quantity of water being pumped through it.

The chart is valid for use with diesel engines where the heat absorbed by the cooling water is known. Heat rejected to the jacket water varies with engine design and other factors. However, in typical engines, 27 percent of the heat in the fuel usually goes to the jacket water. In turbocharged engines this may decrease to 23 percent of the heat in the fuel.

CHART IV
Estimating Steam for Heating Water

Refineries and petrochemical plants heat water for a number of purposes. Hot water may be used in process work, for cleaning, in personnel showers and lavatories, and for many other jobs. Since steam is almost the universal heating medium for these purposes it is often necessary to find how much steam is needed to heat a certain quantity of water per hour through a given temperature range. This chart simplifies these calculations by eliminating reference to conversion factors and steam tables. It is based on use of low-pressure steam for heating the water but may be used for moderately higher pressures without too much inaccuracy. Since results obtained for higher pressures are slightly greater than would be obtained by use of an equation they are generally on the safe side. Use the chart as follows:



Example: A refinery process operation requires 400 gallons per hour of water which must be heated from 60° to 160° F. How much low-pressure steam is needed to heat this water?

Solution: The temperature rise of the water is 160-60 or 100° F. Enter the chart at the lefthand scale and from 400 gallons per hour draw a straight line through 100° F. temperature rise on the central sloping scale. Continue this line to the righthand scale and read 333 pounds of steam per hour needed to heat the water.

This chart has other uses too. For instance, suppose we know that 1000 pounds of steam per hour is available in a refinery for water heating. By starting at the right and projecting across to the left we can find how much water can be heated through a selected temperature rise or the temperature rise obtainable when heating a certain quantity of water every hour. The chart is suitable for both design and operation. For the latter it is useful in heater performance checks. Of course, you must remember that as the pressure of the heating steam increases the accuracy of the chart results decrease somewhat.

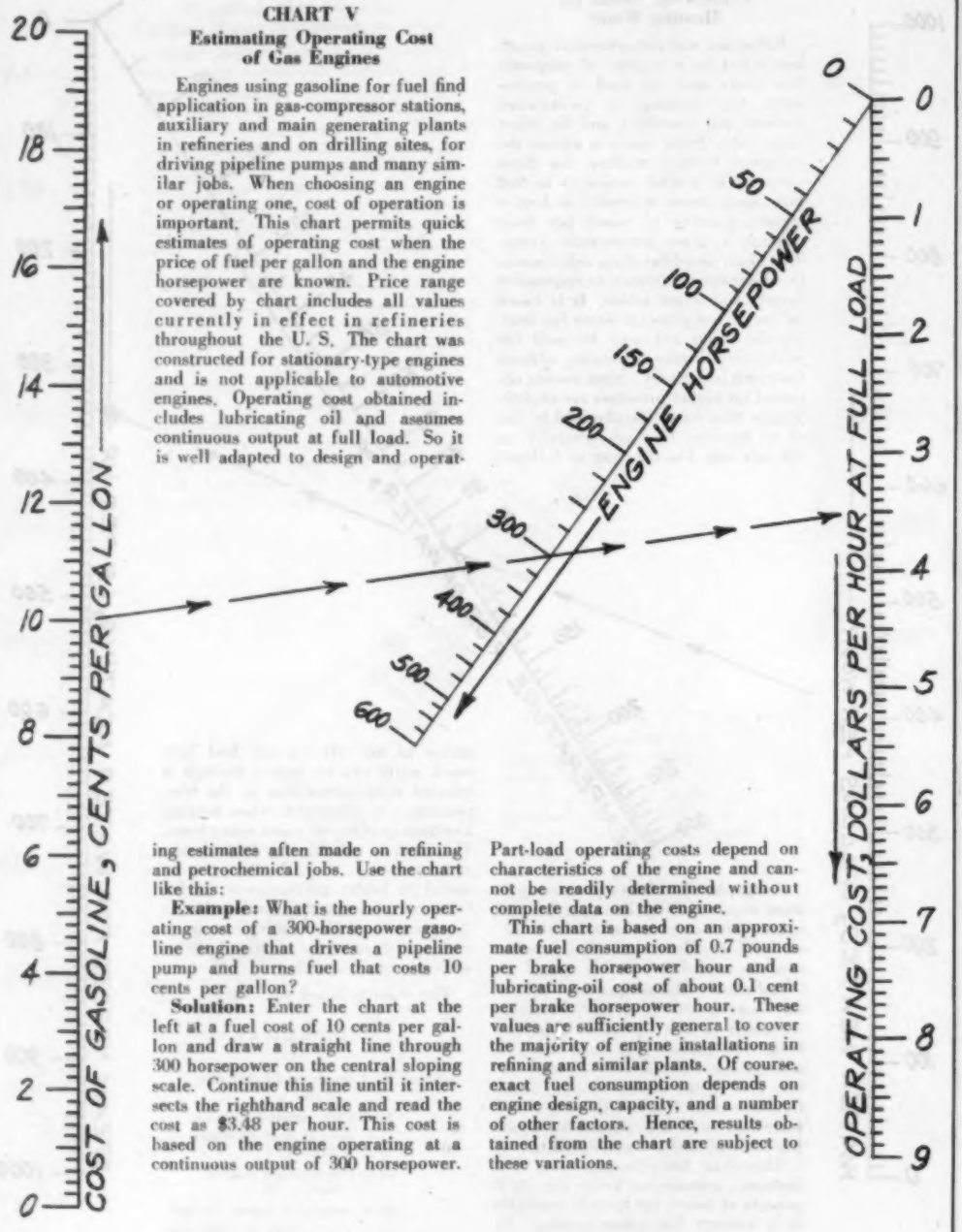
The chart is based on

$$S = \frac{G(C)(\Delta t)(W)}{L}$$

where S = steam to heat water, lb./hr.
G = water heated, gal./hr.
C = specific heat of water, Btu./lb.°F.
Δt = temperature rise of water, °F.
W = weight of water, lb./gal.
L = latent heat of vaporization of steam, Btu./lb.

CHART V
Estimating Operating Cost of Gas Engines

Engines using gasoline for fuel find application in gas-compressor stations, auxiliary and main generating plants in refineries and on drilling sites, for driving pipeline pumps and many similar jobs. When choosing an engine or operating one, cost of operation is important. This chart permits quick estimates of operating cost when the price of fuel per gallon and the engine horsepower are known. Price range covered by chart includes all values currently in effect in refineries throughout the U. S. The chart was constructed for stationary-type engines and is not applicable to automotive engines. Operating cost obtained includes lubricating oil and assumes continuous output at full load. So it is well adapted to design and operating estimates often made on refining and petrochemical jobs. Use the chart like this:



Example: What is the hourly operating cost of a 300-horsepower gasoline engine that drives a pipeline pump and burns fuel that costs 10 cents per gallon?

Solution: Enter the chart at the left at a fuel cost of 10 cents per gallon and draw a straight line through 300 horsepower on the central sloping scale. Continue this line until it intersects the righthand scale and read the cost as $3.48 per hour. This cost is based on the engine operating at a continuous output of 300 horsepower.

Part-load operating costs depend on characteristics of the engine and cannot be readily determined without complete data on the engine.

This chart is based on an approximate fuel consumption of 0.7 pounds per brake horsepower hour and a lubricating-oil cost of about 0.1 cent per brake horsepower hour. These values are sufficiently general to cover the majority of engine installations in refining and similar plants. Of course, exact fuel consumption depends on engine design, capacity, and a number of other factors. Hence, results obtained from the chart are subject to these variations.

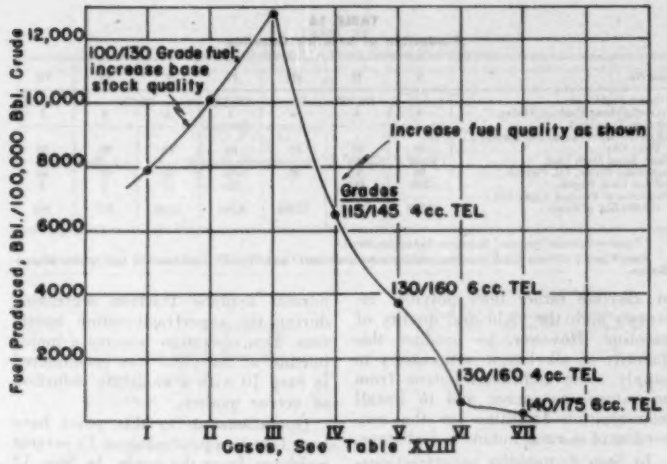


Figure 8. Effect of Base Stock Quality and Fuel Grade on Potential Aviation Fuel Production.

Production of High-Octane Gasoline Components

PART III.

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This is the final part of a discussion of the chemical conversions effected in refining processes currently in use for the manufacturer of components of motor and aviation gasolines. Especially treated is the behavior of various hydrocarbon types rather than of individual compounds because of the complex composition of petroleum fractions. To show the significance in refining operations of the processes described, calculations presented reveal the effect of the progressive application of various processes on the yield and octane quality of motor and aviation fuels for a given refinery situation.

Application of Various Processes In Producing Aviation Gasoline From Crude

A NUMBER of the processes that have been described for the production of gasolines are being used at the present time primarily for the production of premium quality aviation gasoline (Grade 100/130 and higher). As the octane requirements of automotive fuels continue to increase, these processes will be more widely used in the production of motor gasolines. In general, these processes represent relatively high cost operations, and include alkylation, isomerization, superfractionation of light naphthas, and extracting of hydroformates to obtain purified aromatic concentrates. High quality aviation gasolines usually contain the following components: alkylate, isopentane, selected light virgin naphtha fractions (or products of isomerization), and a limited quantity of aromatics.

In Table 16 and Figure 8 are listed the quantities of various grades of aviation gasoline producible, with the use of tetraethyl lead, on the basis of processing 100,000 barrels per day (B/D) of average crude. The cases are based on the use of butenes alkylate, various naphtha blend stock fractions, and isopentane of varying degrees of purity; toluene is included in some cases. The maximum production of Grade 100/130 fuel (12,988 B/D) is obtained in Case III with superfractionation of the light naphtha. Increasing the octane quality to Grade 115/145 in Case IV reduces the production to 6552 B/D, and in Cases V and VI, production of 130/160 Grade fuel is shown to be 3708 B/D with 6 cc TEL/gallon and 617 B/D with 4 cc TEL/gallon. Only 292 B/D of 140/175 Grade fuel can be produced (Case VII) even with 6 cc TEL/gallon.

The key to the production of extremely high quality aviation fuels lies in a relatively small number of hydrocarbon compounds. These compounds are listed in approximately decreasing order of octane quality in Table 17. Triptane heads the list with a Performance Grade of 185/255; the next compound listed is 2,3-dimethylbutane, the principal constituent of ethene alkylate. The trimethylpentanes listed are present in butenes and pentenes alkylates, but their separation from associated lower quality isoparaffins requires a difficult fractionation step. The 2.2-dimethylbutane is produced in the isomerization of hexanes. The high-purity aromatics shown are producible from treatment of hydroformates. Average butenes/pentenes alkylate is listed to indicate its relatively low quality as compared to the above pure compounds.

Application of Various Processes In Producing Motor Gasoline From Crude

Table 18 is offered as an illustrative example of the cumulative effect of the sequential addition of selected refinery processes in producing high octane motor gasoline from an average crude petroleum. This tabulation is subject to several qualifications, as follow:

1) Although no attempt has been made to balance volatility on the various gasoline pools, in most instances a satisfactory average volatility is obtained.

2) Vapor pressure adjustments are indicated only in Steps 12, 13, and 14. In some of the intermediate steps, where thermal cracking has been eliminated and available C4 and C5 olefins are being polymerized or alkylated, a minor increase in gasoline yield would result from the inclusion of extraneous normal butane for vapor pressure adjustment.

3) In some cases the gasoline yield from crude could be increased moderately, usually with a small loss in octane quality, by employing severe thermal recracking of heavy cycle oils from previous cracking operations to ultimate yield of gasoline. This procedure was omitted on the assumption that the refinery would desire to maintain a fairly balanced production of middle distillates and residual fuel oil along with its gasoline production.

4) The gasoline yields and octane qualities obtainable from the various processes are subject to variation with selection of operating severity. The figures used in this study are taken as being representative of average operation at normal operating pressure.

5) In some cases, appreciable variations on the basis of crude source can be expected. In view of these qualifications, the gasoline yields and octane qualities shown are to be considered only as good approximations presented to illustrate trends in modern refining operations for gasoline production.

At the beginning of the tabulation are shown the yields of primary products from conventional refinery distillation of an average crude mixture. Included among these products is the 25 percent of low-octane, straight-run gasoline listed in Step 1. Standard initial operations for increasing the yield and octane quality of gasoline from crude are thermal cracking of gas oil and of residuum; the gasoline products from these operations are added to the straight-run gasoline in Step 2. In Step 3, the thermal cracking of gas oil is replaced with the catalytic cracking process, resulting in a significant increase in gasoline quality and yield. In Step 4, thermal reforming of the 200°-400° F. fraction of the straight run naphtha is introduced to increase octane quality at the expense of yield. In Step 5 the thermal reforming of 200°-400° F. virgin naphtha is replaced with hydroforming; hydroforming shows both a yield and an octane advantage over thermal reforming.

In Steps 1 to 5 all of the butanes and pentanes produced, including the olefins, have been blended into the gasoline. In Step 6 the available butenes and propene are charged to a non-selective polymerization process. The polymer produced has a very high Research octane rating, but the effect on the over-all gasoline pool is small because of the small quantity of polymer involved. In Step 7, the non-selective polymerization operation is discontinued, and all available propene, butenes, and pentenes are alkylated with isobutane. The production of alkylate rather than polymer increases both the yield and quality of gasoline. However, to produce this quantity of alkylate it is necessary to supply some additional butane from an extraneous source and to install isomerization facilities for the conversion of normal butane to isobutane.

TABLE 16
Production of Aviation Gasoline

Case No.	I	II	III	IV	V	VI	VII
Aviation Fuel Grade	← 100/130 →			115/145	← 130/160 →		149/175
Tetraethyl Lead Used, cc./Gallon	4	4	4	4	6	4	6
Alkylate Type Used	← Butane →						
Alkylate Fraction Used, Vol. Percent of Total Alky.	93	96	96	96	70	90	90
Naph. Blend Stock Used	C5-250° F.	C5-200° F.	← Superfractionated* →			← None Used →	
Isopentane Purity, Vol. Percent	90	90	90	95	98	98	98
Toluene Used, Barrels	336	994	.....	280	70	0	0
Production of Finished Avgas, Bbl./100,000 Bbl. of Crude	7,986	10,163	12,988	6,552	3,708	617	282

* Superfractionated Naphtha: Isohexane-Isoheptane Blend.

Note: Cases I to V are based on average quality butenes alkylate; Cases VI and VII are based on high quality butenes-alkylate.

In Step 8, naphtha superfractionation facilities are installed to remove the low-octane normal pentane, normal hexane, and normal heptane fractions from the light virgin naphtha; this operation increases octane quality at the expense of yield. In Step 9 the normal pentane and normal hexane fractions removed from the gasoline pool in Step 8 are isomerized and returned to the pool. It is assumed that the normal pentane would be isomerized to ultimate yield of isopentane, and that the normal hexane would be isomerized on a once-through basis. The net result of this isomerization is a substantial increase in yield at the same octane level as is indicated for Step 8.

In Step 10, the toluene-and-heavier product from hydroforming is solvent extracted to produce an aromatics concentrate and a raffinate fraction. The low-octane raffinate is withdrawn from the gasoline pool. This operation effects a substantial increase in octane quality with a sizeable loss in gasoline yield. In Step 11, this raffinate is thermally reformed, together with the normal heptane fraction segregated during the superfractionation operation. This operation restores a major portion of the yield loss encountered in Step 10 with a moderate reduction of octane quality.

TABLE 17
Premium Components for Super Aviation Fuels

Component	True Boiling Point, °F.	Reid Vapor Pressure	Octane Performance Grade with 4.0 cc. TEL/Gallon
2,2,3-Trimethylbutane (Triptane)	178	3.1	185/256
2,3-Dimethylbutane (Diisopropyl)	136	7.4	146/203
2,2,3-, 2,3,3-, and 2,3,4-Trimethylpentanes	236–6	1.0	135/215
2,2,4-Trimethylpentane (Iso-octane)	211	1.5	180/182
2,2,-Dimethylbutane (Neohexane)	122	9.7	146/152
Isopentane (98% Purity)	82	22.0	140/142
M-p-xylenes* (99% Purity)	282	0.4	116/300
Toluene (99% Purity)	231	1.1	96/235
Average Butene/Pentene Alkylate	.....	2.9	116/136

* Superfractionated to remove ethylbegbene and orthoxylene.

Step 11 shows the effect upon the gasoline pool represented by Step 10 of withdrawing certain gasoline components to produce an arbitrary quantity of Grade 100/130 aviation gasoline. Butenes alkylate, isoheptane, isohexane, and isopentane fractions are withdrawn from the pool to produce 13 percent (on crude) of 100/130

Operations up to this point have been based on producing an 18 percent residuum from the crude. In Step 12 this 18 percent residuum is charged to a vacuum flashing operation which takes a heavy gas oil fraction overhead and reduces the residuum to about 11 percent of the crude. In turn, the 11 percent residuum is charged to a deasphalting operation which produces a 70 percent yield of a deasphalted oil and an asphalt residue amounting to about 4 percent of the original crude. The heavy gas oil from the vacuum flashing operation and the deasphalted oil are combined and charged to catalytic cracking. The naphtha from catalytic cracking of these stocks is added to the gasoline pool, and the incremental light olefins produced are included in the alkylation operations. The effect of these operations is to increase markedly the yield of gasoline from the crude. The gasoline pool listed under Step 12 represents the same series of operations that culminated in Step 11, on the basis of incorporating the additional 14 percent of catalytic cracking stock. The thermal cracking of residuum has, of course, been eliminated in Step 12. The gasoline pool produced under Step 12 amounts to 54.7 percent of the crude and has unleaded octane ratings of 94 Research and 85 ASTM Motor. Adjustment of vapor pressure to the 10-pound RVP level with extraneous normal butane increases the gasoline yield to 60.7 percent (on crude) at about the same octane level.

TABLE 18

Processing Gasoline from Crude Petroleum

Primary Crude Distillation	Yield, Volume Percent of Crude
C_4-and-Lighter and Loss	1
C_4-400° F. Gasoline	23
Kerosine Stock	12
Gas Oil	37
Lube Stock	7
Residuum	18
	100

Cumulative Processing Sequence for Increasing Gasoline Yield and Quality

Step No.	OPERATIONS	C_4-400° F. GASOLINE		
		Yield, Vol. % of Crude	Research Octane No.	ASTM Motor Octane No.
1	C_4-400° F. Virgin Naphtha from Crude	23.0	55	53
2	Add Thermal Cracking of:			
	(a) Gas Oil	15.0	70	63
	(b) Residuum	2.7	67	60
	Cumulative Total	42.7	61	57
3	Replace Thermal Cracking of Gas Oil with Catalytic Cracking	16.9	93	79
	Cumulative Total	44.6	70	63
4	Add Thermal Reforming of 200°-400° F. Virgin Naphtha	13.8	80	70
	Cumulative Total	41.2	83	73
5	Replace Thermal Reforming of 200°-400° F. Virgin Naphtha with Hydroforming	15.0	89	79
	Cumulative Total	42.4	86	76
6	Add Non-selective Polymerization of Butylenes and Propylene	2.1	98	83
	Cumulative Total	42.2	86.5	76
7	Replace Non-selective Polymerization of Butylenes and Propylene with Alkylation of Butylenes, Pentylenes and Propylene	7.6	92	91
	Cumulative Total	42.8	87	78
8	Remove by Superfractionation of Virgin Naphtha: Normal Pentane, Normal Hexane, and Normal Heptane Cuts	(4.8)	52	51
	Cumulative Total	37.0	91	83
9	Add Isomerization of:			
	(a) Normal Pentane (To Ultimate Yield)	1.4	88	87
	(b) Normal Hexane (Once-through)	2.2	81	80
	Cumulative Total	40.6	90	82
10	Remove Raffinate Obtained by SO_2 Extraction of Hydroformates	(3.5)	35	34
	Cumulative Total	37.1	95	86
11	Add Thermal Reforming of Above Raffinate and nC_7 Cut from Virgin Naphtha	2.7	74	64
	Cumulative Total	39.8	94	84
12	Add Vacuum Flashing and Desphalting of Residuum to Obtain 14 percent Additional Heavy Gas Oil from Crude for Catalytic Cracking. Catalytic Cracking of this Gas Oil Produces additional Naphtha and Additional Light Ends for Alkylation. Cumulative Gasoline Pool Becomes:			
	C_4-400° F. Naphtha from Catalytic Cracking	22.4	92	78
	Alkylate (Total Propene, Butenes, Pentenes)	11.6	92	91
	Superfractionation and Isomerization Products:			
	Isopentane	3.6	88	88
	Isohexanes	3.6	81	80
	Isoheptane Fraction	3.1	72	71
	Extracted Hydroformates:			
	Toluene	1.8	120	110
	Xylenes	3.5	140	120
	Heavy Aromatics	2.9	100	80
	Thermally Reformed Raffinate (Includes nC_7 Frac. from Virgin Naphtha)	2.7	74	64
	Subtotal	84.7	94	84
	Add Extraneous Normal Butane for 10-Lb. RVP	6.0	95	95
	Total Gasoline Pool	90.7	94	85
13	Withdraw for 100/130 Grade Avgas:			
	Butenes Alkylate	4.4	94	94
	Isohexane-Isoheptane Naph. Fractions	6.6	76	75
	Isopentane Fraction	2.0	88	88
	Total 100/130 Avgas (With 4 cc. TEL/Gal.)	13.0	85	84
	Remaining Motor Gasoline Pool	47.7	....	....
	Withdraw Extraneous Normal Butane for 10-Lb. RVP	0.8	95	95
	Final Motor Gasoline Pool	46.9	97	85
	With 1 cc. TEL/Gallon	....	100	88

TABLE 18—Continued

Over-all Crude-Products Balance

Charge:	
Crude	100
Extraneous Butanes (for Alkylation and RVP Req.)	7
TOTAL	107
Products:	
Gasolines (from Step 13)	89
Finished Lube Oils	4
Middle Distillates	20
Fuel Oil	13
Fuel Gas (as Fuel Oil, on Btu Basis)	1
TOTAL	108

Grade aviation gasoline at the 4.0 cc. per gallon TEL level. The remaining motor gasoline pool amounts to about 47 percent of the crude and has unleaded octane ratings of 97 Research and 85 Motor, or 100 Research and 88 Motor with the addition of 1 cc. TEL per gallon.

At the end of the tabulation is shown an over-all balance between crude and the products represented by Step 13. It is assumed that the kerosine fraction from crude distillation will go directly into middle distillates, and that the cycle oil from catalytic cracking boiling above gasoline and below 660° F. will be finished as middle distillate heating oil. It is assumed that the heavy cycle oil from catalytic cracking boiling above 660° F. will be blended into residual fuel oil, along with the residues from lube oil finishing operations and the asphalt from the crude residuum deasphalting operation. Dry gas from cracking, hydroforming, and reforming operations not otherwise utilized is allocated to fuel gas and is listed as equivalent liquid volume, on the basis of its average heating value when assuming a heat content of 6 million Btu per 42-gallon barrel.

It is to be noted that the replacement of thermal cracking with various catalytic processes, together with the alkylation of light olefins on a wide scale, creates a serious deficiency of butanes when producing specification gasolines at the high octane level indicated here. In actual practice, operations would have to be modified to keep butane requirements in balance unless adequate supplies of extraneous butanes could be made available through importations of natural gasoline mixtures or from other sources.

ACKNOWLEDGMENT

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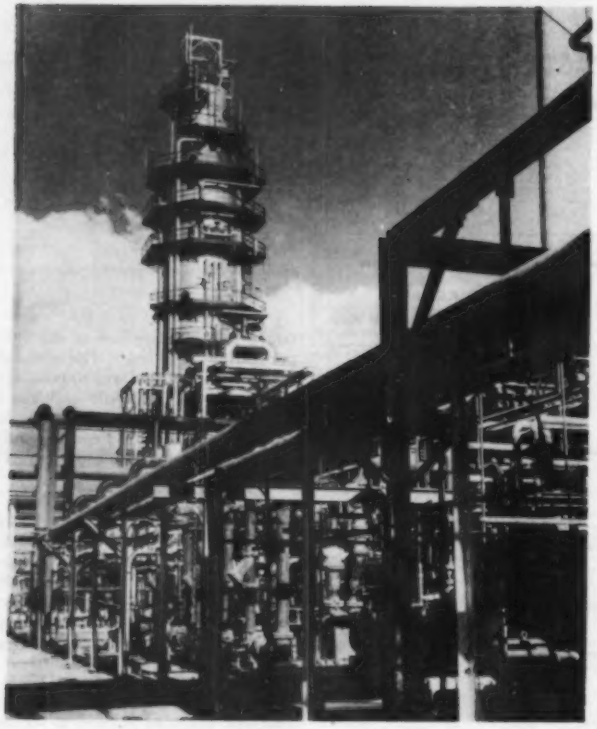
End of Part III and series.



Single Stage Crude Unit at Esso's Plant, Fawley, England.

Fawley on Stream in Time To Relieve Tight Situation

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THAT the Esso Petroleum Company refinery at Fawley, England, should have come on stream during an anxious period occasioned by Iranian nationalization of the Abadan refinery, was a heartening factor in a very disturbing situation. The Fawley refinery went into part operation in July, and although Prime Minister Attlee recently put the refinery "on stream" officially, full capacity by all units will not be reached until the end of next year. During the latter half of this year it is estimated the enlarged refinery will produce 13,160,000 barrels of finished products, including about 4 million barrels of high grade motor gasoline. The completed refinery, costing about $150 million, will have an annual output of in excess of 42 million barrels of petroleum products.

The original Fawley plant handled a total of 21,000 barrels per day for the following percentages of finished items by volume on crude: gasoline 25.5; gas-oil 42; marine fuel oil 25.5; and commercial gases 0.5.

Sulfur Plants

About 10,000 barrels per day of the crude distillation operations will be continued as such. By revamping the remaining facilities, two thermal reforming units have been completed and are being utilized for improving the octane rating of the heavy straight-run gasoline from the two new distillation plants. The remaining facilities comprising shell stills, have been converted to re-run operations on such streams as solvent naphthas, SO_2 extract, etc. Since most of the Middle East crudes rate high sulfur content, sulfur treating will assume an important processing status.

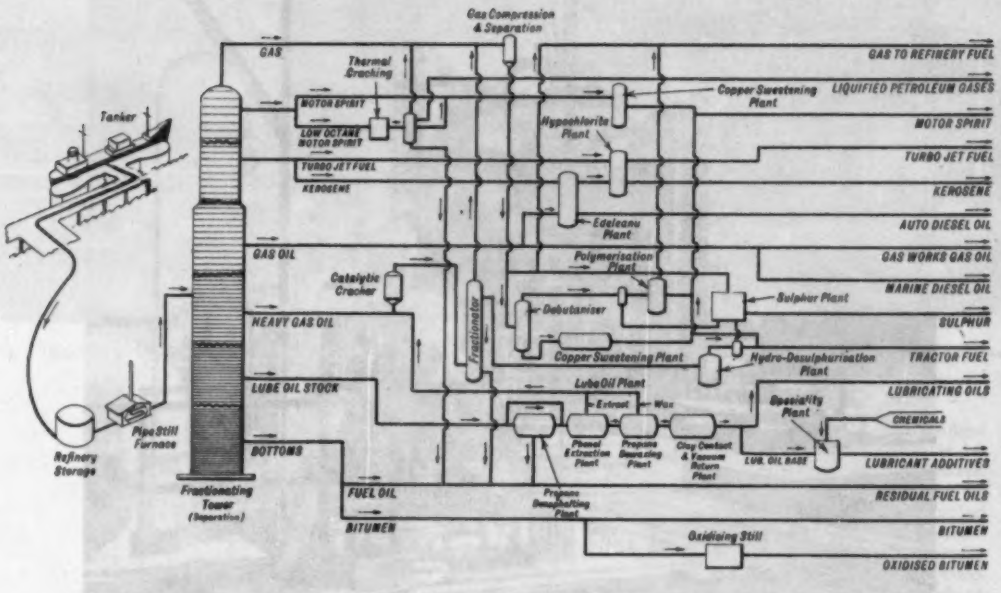
Four new treating units have been added, and the existing doctor sweetening facilities have been modified to conform to the general operational program. New facilities comprise a hypochlorite unit for treating solvent naphthas and kerosines including jet fuel; two copper chloride units for finishing virgin and cracked naphtha and gasoline components; and an Edeleanu sulfur dioxide extraction unit of 13,000-barrels-daily capacity and of Badger design. The latter is for the treatment of kerosine, the extract from which will be used for gasoline and tractor fuel. It will also be employed to treat the straight-run gas-oil to reduce sulfur content, the extract being utilized for fuel blending. The use of sulfuric acid for refining operations at Fawley is not envisaged now or in the future, and this materially reduces the problem of water pollution, an important factor in a plant of this size.

In the design, engineering and construction of the Fawley project, Esso Engineering Division of Standard Oil Development Company collaborated with Foster Wheeler Corporation. The actual work was executed by Foster Wheeler Ltd., a British affiliate of the U. S. firm.

Other Processing Units

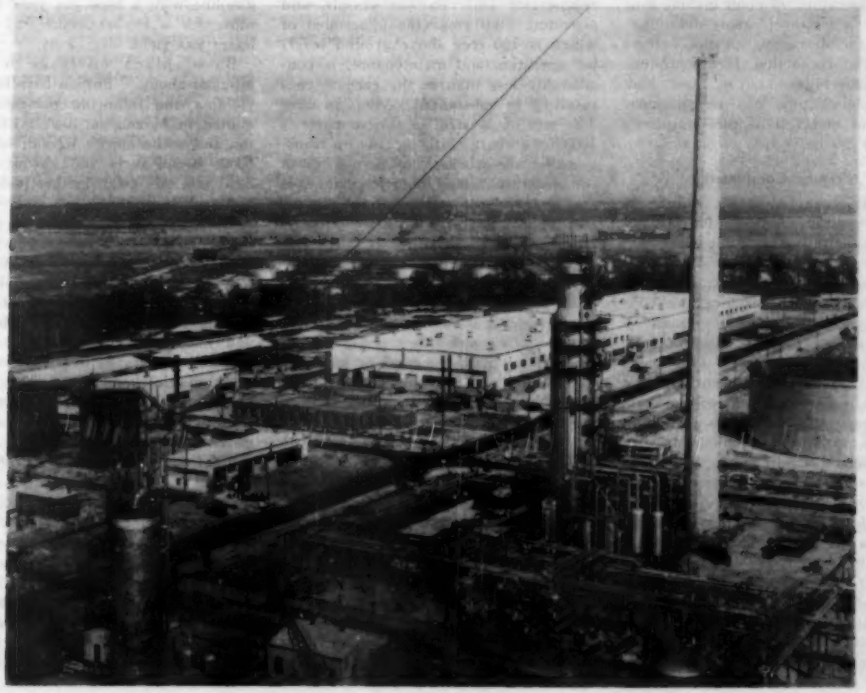
The first construction phase, now completed, entailed the erection of nine major processing units for producing finished petroleum products. Designed for a maximum yield of distillate fuels, they comprise two crude distillation units with a combined daily charging capacity of 128,000 barrels, a fluid catalytic cracker and the requisite auxiliary facilities for treating, power, maintenance and operation.

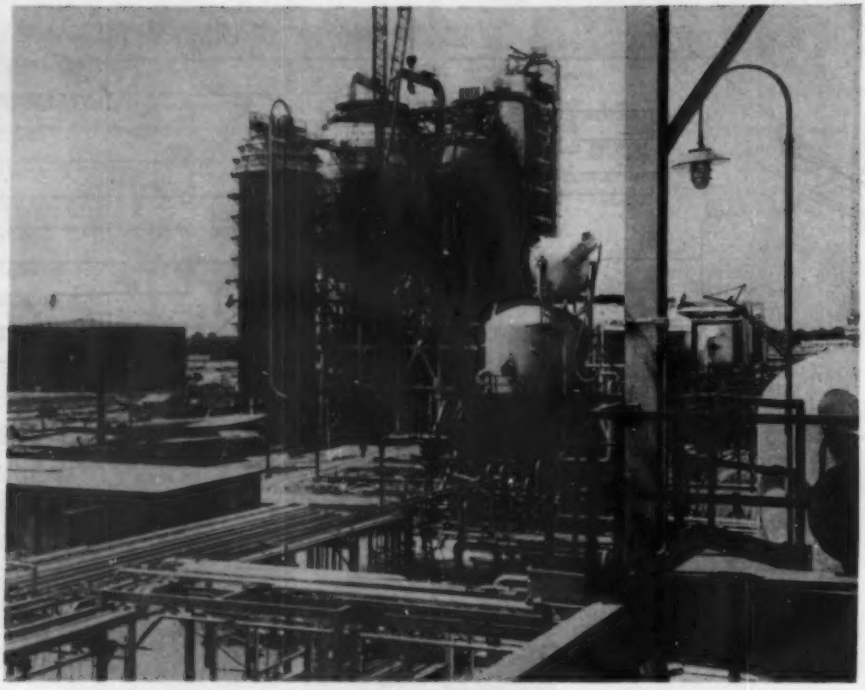
The finished refinery calls for the construction of a solvent lubricating oil plant, a catalytic polymerization unit, and facilities for producing tractor fuel and extracting elementary sulfur from refinery gases. Increased gas output from the enlarged fluid catalytic cracking operations will be utilized by the catalytic polymerization unit, which will upgrade cracked gases to high-octane gasoline components. New treating facilities are being added for the production of tractor fuel, which will call for some increase in crude runs. Plans



Flow Diagram, Esso Fawley Refinery.

View from the Cat Cracker Showing the Single Stage Crude Unit, the Maintenance Building, and the Marine Terminal in the Background.





Cat Cracker from Single Stage Crude Unit.

for the lubricating oil plant include four processing units for propane deasphalting, propane dewaxing, phenol extraction and clay contacting. It will produce high-viscosity-index stocks and low cold-test lubricating oils in sufficient quantity to meet all of the company's marketing needs.

Already Completed

The new crude distillation facilities at Fawley comprise one 65,000-barrel-daily single-stage atmospheric unit and a 60,000-barrel-daily combination atmospheric and vacuum unit. The single stage unit is designed to produce the conventional straight-run distillate cuts including gasoline, naphtha, kerosine, gas-oil, and diesel fuels, reducing crude charge to about a 25 percent residual fraction. The two-stage unit will separate an additional gas-oil distillate fraction and will later provide distillate and residual stocks for lube manufacture, reducing crude to approximately a 20 percent bottom fraction. Heavy naphthas from both units will be thermally reformed in an existing unit.

The 37,000-barrels-per-day Fluid catalyst plant at Fawley is of downflow design, and incorporates several new features leading to lower initial investment, greater simplicity of operation and ease of maintenance. Thus the height of steel structure supporting the regenerator and reactor vessels, and providing platforms (the uppermost of which is 160 feet above ground level) for operation and maintenance, is considerably less than in the earlier types resulting in substantial savings in cost. The weight of steel in the supports is 1300 tons. An elevator speeds up transportation of workers to points up in the structure. Large diameter manheads are provided on all principal vessels and piping at critical locations. Trolleys and hoists are installed to the slide valves, large safety valves and manheads to save the time and cost of putting up temporary rigging.

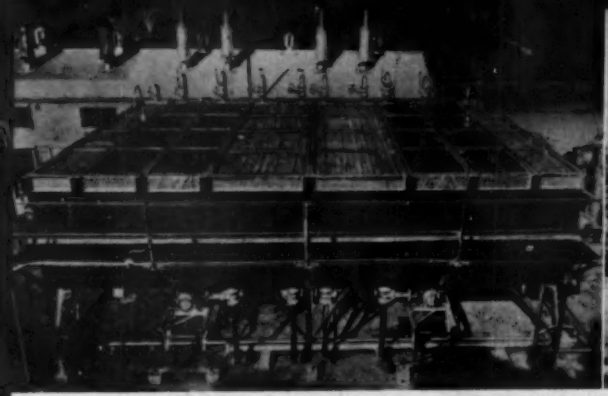
Strategic locations up in the structure have welding and other power outlets to do away with the need of stringing extension leads from the ground with attendant safety hazard. The general layout of pumps, exchangers, etc., throughout the unit is such as to facilitate ready access with mobile equipment during shutdown periods so that plant parts can be rapidly dismantled and removed to the central workshop for repairs. There are special platforms inside the regenerator and reactor for the inspection and maintenance of cyclone separators, and external platforms on all points requiring maintenance.

The cat cracker is designed to operate with two different types of catalyst, one for the production of high-octane gasoline with a high gas yield and the other for a lower octane fuel with a lesser gas yield.

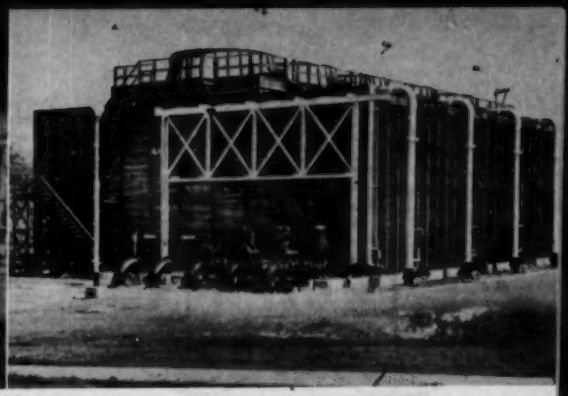
Basic plans envisage a crude input of about 37 million barrels a year, yielding the following principal items quoted in barrels-per-day; crude naphtha and white spirits, 42,500; kerosines, 6000; diesel fuels and gasoils, 14,000; light fuel oils, 6000; bunker fuel, 30,000; and asphalts, 3500.

Although the presence of the older refinery meant numerous advantages in favor of building on adjoining land, this factor was only an additional reason for selecting Fawley as the site of the new plant. Availability of skilled labor and marketing economies, land structure and topography which offered cheap and quick development, and an ideal location in terms of distribution throughout the entire United Kingdom were decisive factors.

The new Esso Fawley refinery is making a two-fold contribution to Britain's finances: a 20 to 30 percent total in the difference between the cost of crude imports and the cost of equivalent finished products will be realized; secondly an economy will be had through the purchase of Middle East rather than Western Hemisphere crude. It is calculated that Fawley operations will save Britain about $2 million a week in petroleum economy.



Three Sets of Coil Sections for Dry-Cooler at Pipeline Station.



Large Capacity Five-Cell Double-Flow Induced Draft Cooling Tower Serving Condensing Equipment in Petroleum Refinery.

Selection and Operation of

Water-Cooling Towers and Air-Cooled Heat Exchangers

HOWARD E. DEGLER

The Marley Company, Inc., Kansas City, Kan.

THE MOST common method of cooling in refineries is by use of water cooling towers. Recently there has been an increasing use of air-cooled heat exchangers. Where high-level heat removal is permissible, these dry-surface coolers have advantages where water is expensive or polluted. Other advantages include small space requirements, simplicity in starting, and ease of control of the freezing hazard.

Normally the cooling tower is more economical, but the cost of the dry-cooler decreases relative to that of the tower as the temperature of the fluid to be cooled rises. A careful evaluation of both methods should be made to insure that the most suitable cooling equipment is selected in each case. An example is given of a cost comparison of these two competitive cooling methods.

Also included is a discussion of the operation and maintenance of both cooling towers and dry-surface coolers. This paper was originally presented before the Petroleum Mechanical Engineering Conference, Tulsa, Oklahoma, September 24-26, 1951 of The American Society of Mechanical Engineers.

RECENT water crisis in the Southwest, California, New York, and elsewhere in the United States have brought to public attention basic shortages of underground and surface water that engineers have been predicting for decades. The conservation and reuse of cooling water has become a necessity in the above and other widely scattered areas, each of which has its individual problem of water supply and usage.

Large water users include power plants, refrigeration, and the manufacturers of petroleum products, chemicals, rubber, paper, textiles, rayon, linen, lactose, sugar, foods, liquors, explosives, hydrogen, steel, and many others. Water usage has doubled in the past decade and today's requirements of many process industries are frequently in excess of 300 pounds of water per pound of finished product. Therefore the selection of the most practicable cooling method for re-use of water or its elimination as a coolant becomes more important as new processes are perfected, industries expanded, and power demands increased.

Mechanical-draft cooling towers can cool water by evaporation to a temperature approaching the wet-bulb temperature of the ambient air. This water-cooling method requires less than one percent evaporation of the water circulated to economically dispose of the process heat load.

Air-cooled (finned-tube) heat exchangers are having increased acceptance and usage for "high-level heat removal" (e.g. above 130° F. referred to 100° F. dry-bulb air), where water is scarce, expensive, and/or badly polluted; low maintenance cost of control are other features.

A water-cooling tower is an enclosed structure for the evaporative cooling of water by contact with moving air, see Figures 1 and 2. Water, when cooled by the evaporative effect, transfers to the air about 1000 Btu per pound of water evaporated. The heat contained in the water vapor thus produced is known as the latent heat of vaporization. Air, absorbing heat from water in this manner, is capable of cooling water below the atmospheric (dry-bulb) temperature. This distinctive fact permits water cooled by the evaporative method to serve applications having a great variety of heat-removal requirements, and it also enables a small volume of water to dispose of a much greater heat load than would otherwise be possible.

In a water-cooling tower, as the water falls from level to level, over the wood filling (Figure 2), it splashes into fine droplets and spreads out over the wood slats in thin films, thus providing additional water surface to the upward-moving air. The rate of heat transfer, hence the water-cooling effect, will be accelerated by: increased air velocity, added water surface, higher hot-water temperature, and lower humidity (wet-bulb) of the air for a given size tower.

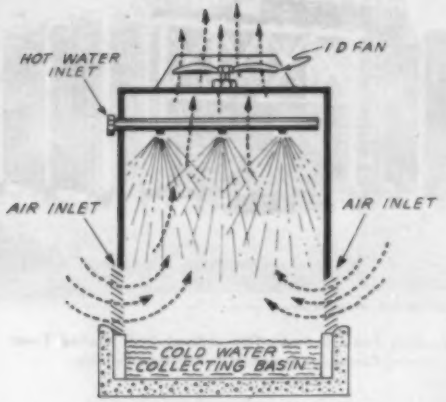


Figure 1. Basic Elements of a Spray-filled Counterflow Water-Cooling Tower.

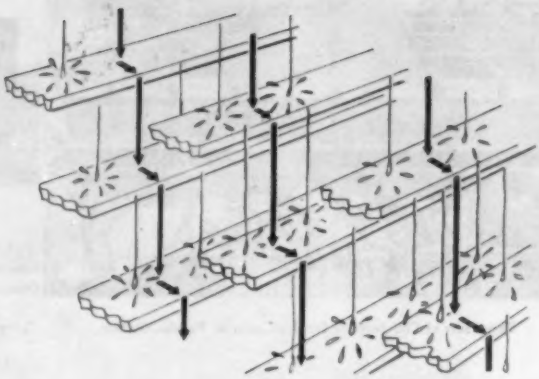


Figure 2. Wood Fill in Towers Provides More Cooling Surface and Water Break-Up.

Cooling Tower Definitions

A WATER-COOLING TOWER is an enclosed device for evaporatively cooling water by contact with air. In atmospheric water-cooling equipment the heat transfer is accomplished partially by a transfer of sensible heat (about 25 per cent) which raises the wet-bulb temperature of the air; but most of the cooling is due to an exchange of latent heat (about 75 per cent) resulting from the evaporation of a small part of the circulating water.

A NATURAL-DRAFT TOWER is one in which the air movement through the tower is dependent only upon atmospheric conditions.

A SPRAY-FILLED TOWER (natural draft or mechanical) is one which is dependent solely on spray nozzles for water break-up.

A DECK-FILLED TOWER is one which contains baffling to increase the water break-up of the distributing system and to provide additional wetted surface.

A MECHANICAL-DRAFT TOWER is one utilizing one or more fans to move air through the tower, the fans being an integral part of the tower.

A FORCED-DRAFT TOWER is a mechanical-draft tower having one or more fans located in the air intake to the tower.

AN INDUCED-DRAFT TOWER is a mechanical draft tower having one or more fans located in the air outlet from the tower.

Operating Terms

Those who operate or manufacture distinctive major mechanical equipment or apparatus gradually develop a somewhat specialized "glossary" of words and phrases that describe particular related functions, parts, or characteristics of such equipment. The most common of such terms as applied to atmospheric water-cooling equipment are the following:

COOLING RANGE is the number of degrees F that the water is cooled with the water-cooling equipment. It is the difference in temperature between the hot water coming to the cooling tower and the temperature of the cold water leaving the tower.

APPROACH is the difference in degrees F between the temperature of the cold water leaving the cooling tower and the wet-bulb temperature of the surrounding air.

HEAT LOAD is the amount of heat dissipated by the water-cooling tower in Btu per hour (or per minute). It is equal to the pounds of water circulated times the cooling range.

PUMPING HEAD is the pressure required to lift the water from the top of the water in the basin to the top of the tower and force it through the water distribution system. It is equal to the static head plus the velocity head and friction loss in the water system.

DRIFT is the small amount of water that escapes from atmospheric water-cooling equipment in the form of fine droplets and is that water which is entrained by the circulating air. Drift is a water loss independent from that water lost by evaporation; it can be reduced by good design.

BLOW-DOWN (bleeder by-pass or waste) is the continuous or intermittent wasting of a small part of the circulating water in order to minimize harmful concentrations of chemicals in the water. In most localities the water used in a cooling tower contains dissolved solids. The water that is evaporated in the tower does not carry away its solids and as a result the solids concentration is built up unless some of the concentrated water is drained off and replaced with make-up water. These solids decrease the evaporative properties of the circulating water, and they may cause sludge dposits in the system or corrosion of metals.

MAKE-UP water is that required to replace the water lost by evaporation and drift and blow-down.

The type of water-cooling equipment used affects to a considerable extent the operating temperatures of the fluid to be cooled. Spray ponds and natural-draft towers depend upon prevailing winds for cooling the water, hence these units must be designed, built, and selected for low wind velocity conditions. Such equipment cannot continuously maintain the desired cold-water temperature (or a close approach to the wet-bulb air temperature), hence mechanical-draft equipment must be employed to produce the required air movement and obtain low cold-water operating temperatures.

Progress of the cooling tower industry is apparent when it is realized that for a definite need, a modern water-cooling unit requires only one square foot of ground area as compared to 50 square feet for the spray pond and about 1000 square feet for a natural cooling lake or pond. The continuous demand for a more compact design, better construction, lower cost, larger capacity, greater flexibility of operation, independence of atmospheric uncertainties, and improved all-around performance has resulted in the modern induced-draft water-cooling tower.

A dry-surface cooling unit is a device for cooling or condensing fluids by circulating them through finned tubes and forcing or inducing atmospheric air across the coil sections. The dry-surface cooler is basically a non-contact convection-type heat exchanger. One arrangement for a dry-cooler is the induced draft unit (Figure 3) with the fan mounted on top discharging the air upward and inducing air across a horizontal bank of finned tubes mounted below the fan. Another arrangement is the forced-draft unit (Figure 4) with the fan discharging

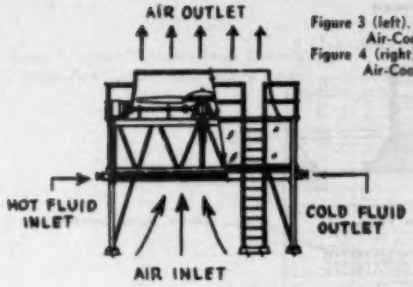
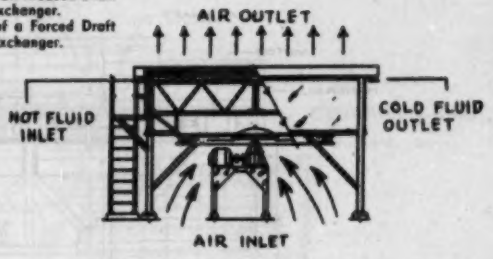


Figure 3 (left). Section of an Induced-Draft Air-Cooled Heat Exchanger.
Figure 4 (right). Section of a Forced Draft Air-Cooled Heat Exchanger.



air upward across a horizontal bank of finned tubes mounted above the fan. Small portable units are conventionally arranged with a vertical coil-bank mounted to receive a horizontal stream of air across the finned surfaces.

Selection of type of dry-surface cooler may be based upon the design considerations and operating characteristics shown in Table A.

TABLE A

Induced Draft	vs.	Forced Draft
1. Less recirculation of outlet air.		1. Mechanical equipment is simpler and more accessible.
2. Better air distribution over coils.		2. Simpler structure (isolated drive).
2. Coil sections close to ground, easier to clean.		3. Unitized or other than electric-motor drive.
4. Maximum protection from weather.		4. Less power (± 5 percent).
5. Walkway unnecessary.		5. Increased freezing hazard.

The dry-cooled heat exchanger may be used for applications of "high-level heat removal" where temperatures of the fluids to be cooled are above 130° F., referred to a 100° F. dry-bulb ambient air temperature, and where water is scarce, expensive and/or badly polluted, or where the "portable" features of a dry-cooling unit would be desirable. Other advantages include small space requirements, simplicity in starting, and ease of control of the freezing hazard.

The water-cooling tower would generally be used in preference to the dry-cooling unit when cold-water temperatures are less than 130° F. and which could approach (within a few degrees) the wet-bulb temperature of the air, e.g., 85° F. cold-water to an 80° F. wet-bulb. Other tower advantages are the wide range of cooling applications especially adaptable to low temperature cooling as required for steam power, refrigeration, foods, etc., and especially applicable for economically cooling very small (5 gpm) or very large (over 30,000 gpm) capacities.

Normally the cooling tower is more economical, but the cost of the dry-cooler decreases relative to that of the tower as the temperature of the fluid to be cooled rises. Both units have their own applications but in some instances either type may be used. A careful evaluation (see page 149) of both methods should be made to insure that the most suitable cooling equipment is selected in each case.

When selecting the design air temperature for dry-surface coolers, it is generally acceptable to choose a dry-bulb temperature[1] which will not be exceeded more than 5 percent of the hours between noon and midnight during the months of June to September, inclusive. The temperatures that occur in excess of this design value will be of such short duration as not to have an appreciable effect on efficiency or performance. Generally used dry-bulb design temperatures are 95° to 110° F.

Cooling Range, see Figure 5a, is the number of degrees that the fluid is cooled in an air-cooled heat exchanger. Approach is the difference between the temperature of the cold fluid leaving the dry-cooler and the dry-bulb temperature of the ambient air.

Theoretically, water may be cooled by the evaporative method (as in a cooling tower) until its temperature is lowered to the air's wet-bulb temperature. In practice, however, water is cooled to a temperature approaching the wet-bulb; the closer this "approach" the larger the size of the cooling equipment required for a given duty. Generally used wet-bulb design temperatures[1] are 70° to 80° F., depending upon the service and geographical location of the unit.

Cooling range, see Figure 5b, is the number of degrees that the water is cooled with water-cooling equipment. It is the difference between the temperatures of the hot water coming to the equipment and temperature of the cold water leaving. Approach is the difference between the temperature of the cold water leaving the cooling equipment and the wet-bulb temperature of the ambient air.

Water Cooling Towers

Types. The mechanical-draft tower consists of an upright shell constructed of wood, metal, transite, or masonry, in which water is distributed near the top uniformly over the area, this water drops through upward moving air circulated by fans and falls into the cold-water collecting basin.

Performance of mechanical-draft towers is practically independent of wind velocity hence it is possible to design them for more exacting performance. They require less space and less piping than natural-draft towers, and the pumping head varies from 12 to 50 feet, depending upon the design. Higher plant economy due to the colder water temperature obtained generally more than offsets the additional operating expense and initial cost as compared with natural-draft towers.

A forced-draft tower is a mechani-

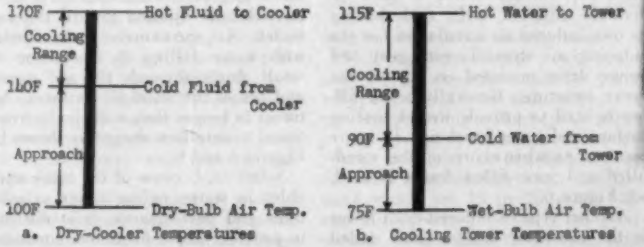


Figure 5. Definition of "Cooling Range" and "Approach" for Air-Cooled Heat Exchangers and Water-Cooling Towers. (Temperatures in above diagrams are illustrative only, subject to wide variation.)

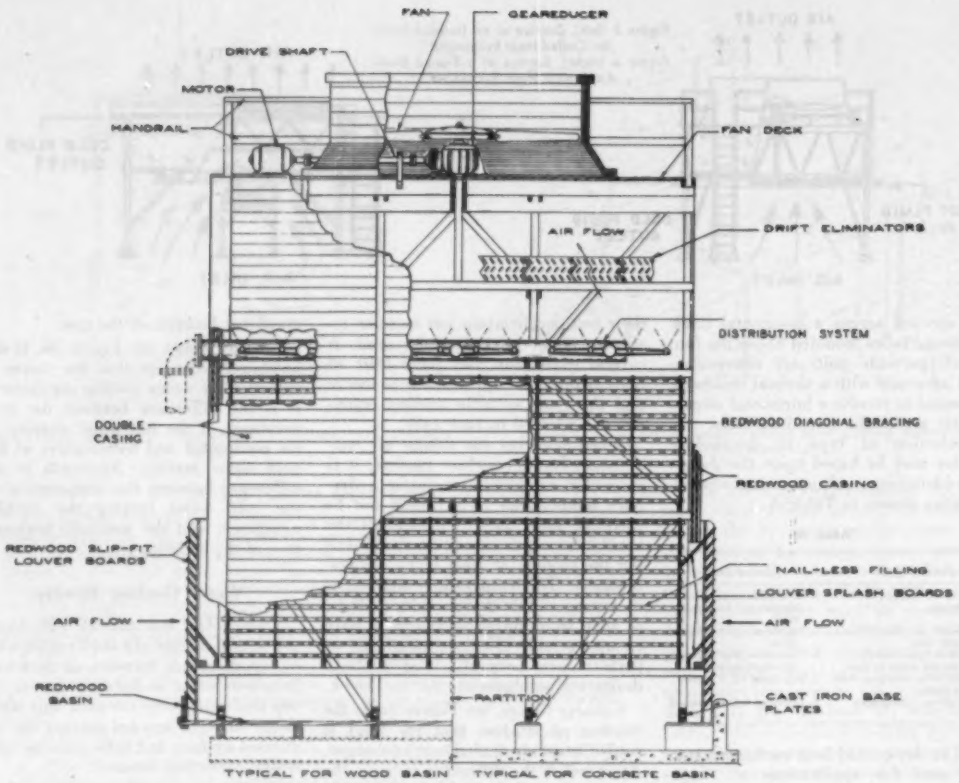


Figure 6. Section Through an Induced-Draft Counterflow Water-Cooling Tower.

cal draft-tower having one or more fans located in the air intake to the tower. Greatest objection to the forced-draft tower design is that the heated air leaves the top of the tower at a low velocity and is subject to "recirculation" to the fan inlet; this action may reduce performance as much as 20 percent. Operating costs are high because of high fan power requirements, and maintenance and depreciation both are high by modern standards.

A "conventional" induced-draft cooling tower consists of one or more individual adjacent cells, each having its own induced air-circulation fan (in outgoing air stream), with gear and motor drive mounted on top of the tower structure. Generally wood filling is used to provide wetted cooling surface and water break-up. In many cases, a combination of the wood-filled and spray-filled design is used, see Figure 6.

Another type of induced-draft tower is the crossflow design (also called "double-flow"), Figure 7, which provides compactness, open accessible hot-water distribution system, low pumping head, low draft loss because of large air-inlet and drift-eliminator area and air flow being parallel to flat side of fill surface height approximates tower height, and increased flexibility for varying performance requirements, with heavy water loadings being possible.

This distinctive tower, Figure 7, employs multiple fans (adjustable pitch blades) centered along the top, each fan drawing air through two cells paired to the plenum chambers which is partitioned beneath each fan and fitted with drift eliminators that also turn the air upward toward the fan outlet. Air movement is horizontal with water falling in a cascade of small drops through the air stream and across the wood-fill surfaces. Air travel is longer than with the conventional counterflow design as shown by Figures 1 and 6.

Selection. Because of the many variables in water-cooling tower calculations and performance, it is difficult to provide simple handbook equations and tables whereby an engineer can readily select the type and size of unit for a definite water-cooling requirement. Each manufacturer has a semi-confidential method of sizing a tower, based largely upon research and actual performance tests. Selection of cooling equipment for any specified service must ultimately depend upon overall considerations established from reliable design and performance data.

The performance of a cooling tower is improved by increasing the amount of filling, height, area, and/or air quantity. Increasing the tower height increases the length of time the air is in contact with the water, without seriously affecting the fan power required, but increases the pumping power. Increasing the tower area while maintaining constant fan power increases the air quantity somewhat and increases the time that this air is in contact with the water because of lower velocity. The surface area of water in contact with the air is increased in both cases.

Increasing the air velocity through the tower decreases the time the air is in contact with the water, but since a greater quantity is passing through, the average differential between the

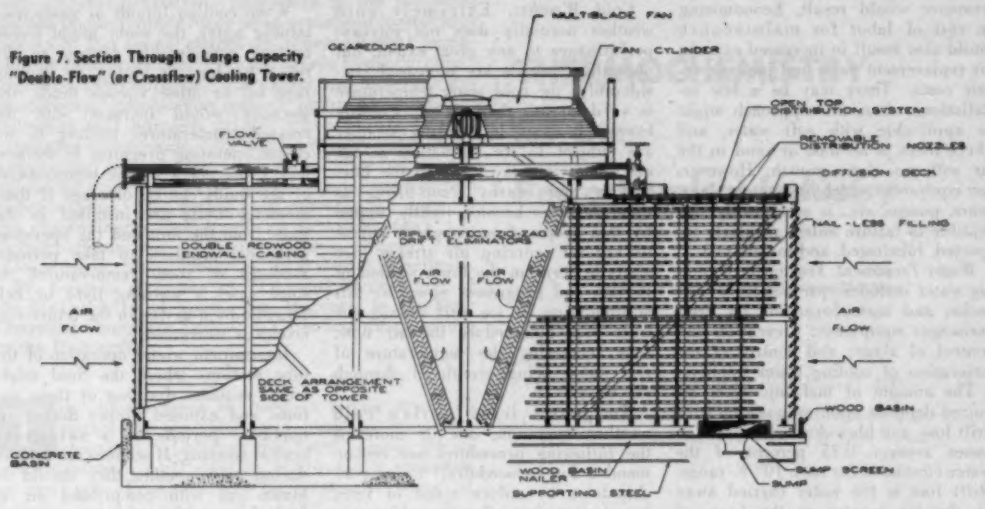


Figure 7. Section Through a Large Capacity "Double-Flow" (or Crossflow) Cooling Tower.

water temperature and wet-bulb temperature of the air is increased, and this increases the rate of heat transfer. Increased air quantities are obtained only at the expense of increased fan power (horsepower increases approximately as the cube of the air quantity). Air velocities through induced-draft towers vary from 300 to 450 fpm over the fill area (plan) of the structure.

Evaluation of Costs

A comparison of costs for various types of cooling equipment for a given application requires detailed study. To obtain an estimate, a complete analysis must be made; first cost, power costs, water costs, maintenance, etc., can be evaluated over the life expectancy of the equipment. The calculation may be made as follows:

Annual operating costs = Maintenance + Depreciation + Power Costs.

$$A = M + \frac{C}{t} + P$$

where A = Annual operating costs
M = Maintenance, insurance, taxes, etc., figure furnished by purchaser.
C = Cost of equipment, would include any or all of: 1) Cost of unit erected; by manufacturer. 2) Pumps, piping, etc.; by purchaser. 3) Electrical work; by purchasers.
t = Time in years, estimated life of equipment.
P = Power costs per year for fan/s and pump/s.

Example. A 900 bhp, 300 rpm, two-cycle, solid injection, pump scavenged, diesel engine in Oklahoma is to be cooled with recirculated water. Make necessary estimates and select cooling equipment required. Prepare an evaluation showing cooling tower and air-cooled exchanger costs upon a basis of operation at full fan speed for 24 hr/day, 8 mo/yr for 15 yr, power at $0.015 per kwh.

Calculation. The cooling system for this type diesel engine absorbs about 2500 Btu per bhp-hr. Assume a shell-and-tube exchanger (with cooling tower) designed to cool jack water from 170° to 158° F., and that the raw water temperatures are to be 115° and 95° F. to a 73° F. design wet-bulb air temperature.

Heat to water = 900 bhp × 2500 Btu = 2,250,000 Btu per hour.

$$\text{gpm} = \frac{2{,}250{,}000}{60 \times 8.33 \times 20^{\circ}} = 225 \text{ gpm raw water circulated through tower}$$

$$\text{gpm} = 225 \times \frac{115^{\circ} - 95^{\circ}}{170^{\circ} - 158^{\circ}} = 385 \text{ gpm soft water through engine jacket}$$

Power Cost = $0.015 × 24 × 30 × 8 = $86.40 per Kw per year

(See Table B.)

Operation and Maintenance

Pages of recommendations could be written on the starting-up, operating, maintaining and shutting down of cooling equipment in order to obtain optimum results under varying load requirements and changing weather conditions. The life of any piece of cooling equipment is directly dependent upon its built-in features, type of service, severity of operation, general care and maintenance, and climatic environment.

The continued utility of all cooling equipment depends primarily upon the maintenance of the mechanical equipment; next in importance is cleanliness of the unit; water treatment (with necessary blow-down) is a must for most systems using cooling towers.

Well maintained units would probably give good performance for years whereas a neglected unit might decrease its cooling efficiency as much as ½ percent per month for some years. It should be emphasized that there are many cooling tower installations which are 15 to 20 years old, and still giving practically as good service as the day they went into operation.

Unless a good maintenance schedule is followed, decrease of cooling per-

TABLE B
Evaluation Costs of Cooling Tower and Air-Cooled Exchanger for Same Cooling Requirements

900-HP. Diesel Engine—5760 Hours per Year (8 Months)
355 gpm Soft Water, 170° to 158° F.
225 gpm Raw Water, 115° to 95° F.

Equipment, Maintenance and Power Costs	Cooling Tower	Air-Cooled Exchanger
Cooling Tower and Basin	$1800	.....
Shell-and-Tube Heat Exchanger	950	.....
Pump (raw water) with Motor	350	.....
Air-cooled Exchanger with Foundation	.....	$2900
Piping and Soft Water Pump	400	400
Electrical Work	350	300
Cost of Equipment "C"	$3750	$3600
Maintenance (5% and 3%)	$ 190	$ 110
Water and Treatment Cost	350	20
Insurance at 2%	75	72
Taxes at 1M	38	36
Contingencies at 2%	75	72
Maintenance, "M"	$ 728	$ 330
Fan horsepower	5 hp.	10 hp.
Pump horsepower	3	3
Kilowatts = Hp x 0.746 / 0.88 motor eff.	6.8 Kw	10.2 Kw
Power Costs at $86.40/Kw/Yr., "P"	$ 587	$ 880
Annual Operating Costs, $A = M + \frac{C}{15} + P$	$1565	$1440

formance would result. Economizing on cost of labor for maintenance would also result in increased expense for replacement parts and periodic repair costs. There may be a few installations where this approach might be applicable with soft water, and where there is no dust or sand in the air with no algae growth. However, any equipment which has motors, fans, gears, pumps, etc., is of necessity susceptible to failure unless regularly inspected, lubricated, and maintained.

Water Treatment. Treatment of cooling water includes: prevention of corrosion and scale formation on heat-exchanger equipment; prevention and control of algae; and control of deterioration of cooling tower lumber.

The amount of make-up water required depends upon evaporation loss, drift loss, and blow-down. Evaporation losses average 0.75 percent of the water circulated for each 10° F. range. Drift loss is the water carried away by the air current in the form of droplets or mist. This loss approximates one-tenth of one percent of the water circulated.

The amount of blow-down required depends upon the hardness of the circulating water, the type of water softener or inhibitor used, and the amount of drift loss. Blow-down is normally controlled to maintain the concentration of dissolved and scale-forming solids below the point where the formation of scale would occur or would be caused by corrosion. The total amount of solids introduced by the make-up water equals the total removed by the blow-down, hence the ratio of make-up to blow-down indicates the number of concentrations in the system.

Mechanical Maintenance. A regular daily inspection schedule is recommended to determine whether the cooling equipment is operating properly. The cooling unit in operation becomes but part of a system made up of several other auxiliaries. Therefore, it may be blamed for unsatisfactory performance which is only a symptom of failure in another part of the system.

Reduced cooling range indicates a light heat load or excess water quantity. Increased cooling range indicates heavy load or insufficient water quantity. When a condenser or heat exchanger becomes badly scaled, water quantity circulated is frequently retarded and pumping head increased. Higher cooling water temperatures usually indicate this condition. Thus, if water quantity is incorrect: 1) check pump for speed, pressure, and freedom from air; 2) check condenser for scale, air, or restrictions; and 3) check pipe lines for air, partially closed valves, dirt, or restrictions.

Cold Weather. Extremely cold weather normally does not increase performance to any great extent, but operating hazards are increased considerably; the cold water temperature is seldom less than 60° F. Cooling towers operated in freezing weather are subject to ice formation at the air inlets; ice may form on the inlet louvers and nearby wood-filling as these surfaces become lightly wetted by fine drops of water which splash toward the entering air stream. Ice starts to form on the lower section of louvers and progresses upwards; this accumulation of ice will restrict the inlet area and reduce the air flow, thus increasing the temperature of the water being circulated through the tower.

To prevent icing during cold weather operation, one or more of the following procedures are recommended for induced-draft towers: a) shut-down or reduce speed of fans, but do not shut off water; b) cover upper portion of louvered area with canvas, etc., and/or c) shut off some of the cells.

If ice should form on the louvers and filling, one of the following methods of removal could be used: a) reversing (for a limited time) the rotation of the motor driving the fan and thus blowing the warm air backwards and out through the louvers; b) shut down some fans temporarily but do not shut off water; and/or c) cover upper portion of louvered area with canvas, etc.

Operation and maintenance of the mechanical equipment *for air-cooled heat exchangers* is similar to that discussed on the previous page for cooling towers. Instructions issued by manufacturers should be followed for proper lubrication and care of the equipment. Clean and paint all corrodible metals as required.

Certain fouling factors are used when estimating the size and performance of a finned-tube cooling unit; an increase of operating temperatures and greater pressure drop through a heat exchanger frequently indicates excessive fouling and the need for cleaning of the tubes, internally and/or externally.

Unusually high dry-bulb temperatures of air may prevent an air-cooled heat exchanger from performing according to the design conditions, but most operating problems will arise in cold weather. In cold weather care must be taken that the temperatures of the circulating fluids do not become too low. In some gas-cooling coils hydrates are formed on the walls of the tubes if the gas is cooled excessively and if there is any moisture in the gas.

When cooling liquids or gases containing water, the water might freeze causing considerable damage to the tubes, headers, or piping. In cooling lube oil or other viscous fluids, the viscosity would increase with decreased temperatures tending to increase operating pressures in the system. Close check on the temperatures of the fluids can be obtained if thermometer wells are installed in the lines from the unit and the operating personnel required to take periodic readings of these temperatures. In some cases a warning light or bell actuated by a device in the return coil header is warranted.

Intermittent winter operation of fin-tube sections where the fluid might freeze requires draining of these sections and exposed piping during inoperative periods as a safeguard against freezing. If sections are drained during cold weather they should be blown out with compressed air or flushed out with anti-freeze solution; fin-tube sections are made and installed so that sections will drain, but scale and sludge in tubes may hold enough liquid to freeze and split the tubes. Drain and vent should be left open and a blank flange inserted at inlet flange connection of each drained section. In this way there would be no danger of freezing in the drained section even though the shut-off valve might develop a leak.

Dampers are sometimes provided on dry-cooling units; these should be set so as to vary the air flow across each coil section to provide the desired cooling effect. Cold weather operation requires almost complete closing (setting depends upon air temperature) of the dampers in order to minimize freezing difficulties.

Conclusion

It is impossible to formulate any set of recommendations that would definitely establish the selection of a given cooling method as being the most suitable for any particular application. The anticipated performance, operating features, and ease of maintenance of a proposed installation must be completely analyzed, and the final selection frequently becomes a matter of engineering compromise and personal preference. It is significant that, as the need for water conservation increases, the manufacturers of cooling equipment have been accumulating a great reservoir of experience by continuously making more economical units and more highly specialized applications.

REFERENCE

[1] Consult local U. S. Weather Bureau Statistics or "Summer Weather Data" by J. C. Albright, published by the Marley Company, Inc., Kansas City.

THERMOCHEMISTRY for the Petrochemical Industry

Part XVIII—The Chloroethenes

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THE THERMODYNAMIC properties of the following groups of compounds have been presented in previous papers of this series: paraffinic hydrocarbons,[5] monoolefinic hydrocarbons,[6] cycloparaffinic hydrocarbons,[7] aromatic hydrocarbons,[8] acetylenic and diolefinic hydrocarbons,[9] combustion gases,[10] sulfur compounds,[11] halogens and halogen acids,[12] chloromethanes,[13] cyanogen compounds,[14] the oxides of nitrogen,[15] some oxygenated hydrocarbons—C_1 and C_2,[16] some miscellaneous hydrocarbons,[17] and some C_3 oxygenated hydrocarbons.[4] This paper now presents the data for the chloroethenes—chloroethene (vinylchloride), 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, trichloroethene, and tetrachloroethene.

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THE chloroethenes are used in largest quantities except for the chlorinated methanes previously described.[13] Chloroethene, better known by its common name of vinyl chloride, is growing in industrial use each year. Trichloroethene finds extensive industrial use. The other derivatives are being produced industrially and will undoubtedly be used more extensively. It will be helpful to have thermodynamic data available for these compounds. It is unfortunate that more attention has not been given these compounds so that more complete and more reliable data would exist.

Heat capacities of chloroethenes have been reported by only two authors, shown in Table 1. It is unfortunate that there are no calorimetric points to check the spectroscopic calculations which were made for this paper.

TABLE 1
Reported Heat Capacity Data for the Chloroethenes

COMPOUND	Temperature Range	Method	Workers	References
Chloroethene	291.16—1500° K.	Spectroscopic	Richards	19
1,1-Dichloroethene	.....	.....	.....	..
cis-1,2-Dichloroethene	23.1—240.5° C.	Velocity of Sound	Olson and Brittain	18
trans-1,2-Dichloroethene	24.0—243.7° C.	Velocity of Sound	Olson and Brittain	18
Trichloroethene	.....	.....	.....	..
Tetrachloroethene	.....	.....	.....	..

Figure 1. Molar Heat Capacities of Chloroethenes on Centigrade and Fahrenheit Scales

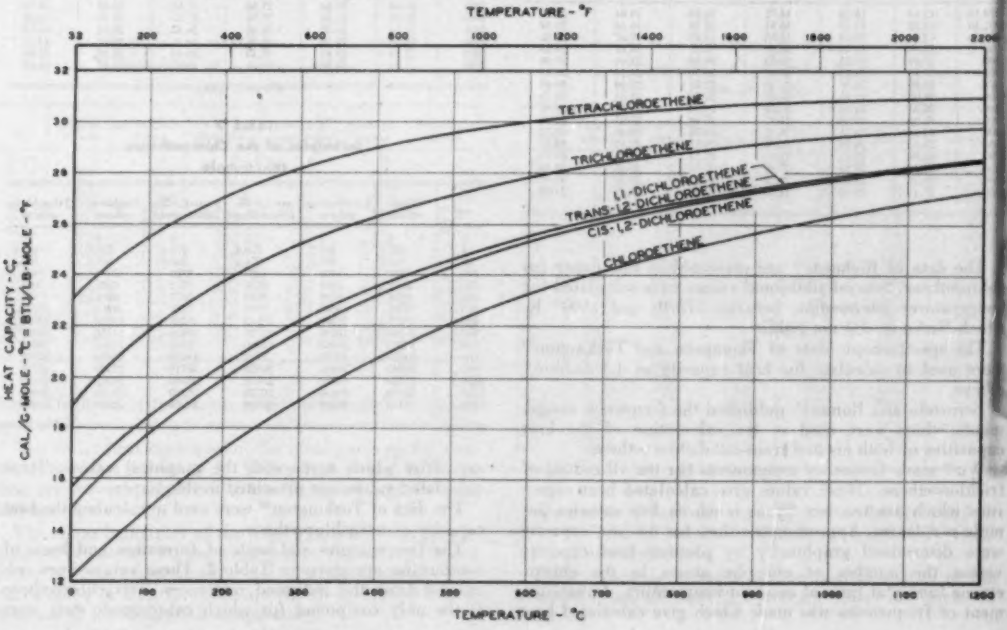

TABLE 2

Free Energies of Formation Heats of Formation, Heats of Combustion, and Molecular Weights of the Chloroethenes at 25°C.[1]

	Molecular Weight	$-\Delta G_f^\circ$ cal./g-mole	$-\Delta H_f^\circ$ cal./g-mole	$-\Delta H_c^\circ$ cal./g-mole CO_2 (gas), H_2O (liq.) HCl (Infinite Dilution)	Reference
Chloroethene	62.501	—11,500	—7,500	303,900	20, 3
1,1-Dichloroethene	96.950	—13,500	—8,000	276,200	21, 3
cis-1,2-Dichloroethene	96.950	—12,300	—6,800	275,000	21, 3
trans-1,2 Dichloroethene	96.950	—12,300	—7,800	275,600	21, 3
Trichloroethene	131.399				
Tetrachloroethene	165.843	—14,300	—6,000	217,600	2, 3

[1] ΔH_f represents the heat evolved at 25° C. and constant pressure in the combustion of the gaseous compounds in gaseous oxygen and liquid water to form the products indicated. All reactants and products are in their appropriate standard reference states.

ΔH_f° and ΔG_f° represent the changes in heat content (enthalpy) and free energy respectively, for the formation of the compounds in the gaseous state from carbon, hydrogen, and chlorine, with all reactants and products in appropriate standard reference states.

TABLE 3

Heat Capacities of the Chloroethenes

cal./g-mole • °C.

t°C.	Chloroethene	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Tetrachloroethene
0	12.12	15.55	14.72	15.24	18.84	23.09
18	12.62	16.13	15.31	15.76	19.45	23.64
25	12.82	16.34	15.53	15.95	19.67	23.83
100	14.38	18.42	17.70	17.95	21.76	25.57
200	17.24	20.54	20.02	20.16	23.61	27.15
300	19.15	22.20	21.80	21.88	25.24	28.23
400	20.72	23.50	23.19	23.26	26.30	28.99
500	22.03	24.56	24.32	24.37	27.11	29.54
600	23.20	25.43	25.28	25.28	27.76	29.95
700	24.13	26.17	26.03	26.05	28.28	30.26
800	24.94	26.81	26.69	26.71	28.71	30.50
900	25.67	27.35	27.25	27.27	29.08	30.70
1000	26.30	27.82	27.74	27.75	29.38	30.85
1100	26.86	28.22	28.16	28.18	29.64	30.97
1200	27.33	28.57	28.52	28.54	29.86	31.07

TABLE 4

Heat Capacities of the Chloroethenes

cal./g-mole • °K.

°K.	Chloroethene	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Tetrachloroethene
273.16	12.12	15.55	14.72	15.24	18.84	23.09
291.16	12.62	16.13	15.31	15.76	19.45	23.64
298.16	12.82	16.34	15.53	15.95	19.67	23.83
300	12.88	16.40	15.59	16.01	19.73	23.88
400	15.56	19.05	18.38	18.56	22.40	26.08
500	17.79	21.03	20.54	20.66	24.24	27.48
600	19.60	22.58	22.30	22.28	25.56	28.46
700	21.09	23.80	23.52	23.58	26.54	29.15
800	22.35	24.80	24.58	24.63	27.30	29.66
900	23.49	25.64	25.47	25.50	27.91	30.04
1000	24.54	26.35	26.22	26.24	28.40	30.33
1100	25.15	26.96	26.85	26.87	28.82	30.56
1200	25.84	27.48	27.39	27.41	29.16	30.74
1300	26.46	27.93	27.86	27.87	29.45	30.88
1400	26.99	28.32	28.26	28.28	29.70	31.00
1500	27.44	28.66	28.61	28.63	29.91	31.09

TABLE 5

Heat Capacities of the Chloroethenes

Btu./lb.-mole • °F.

°F.	Chloroethene	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Tetrachloroethene
32	12.12	15.55	14.72	15.24	18.84	23.09
59	12.56	16.06	15.23	15.69	19.36	23.57
77	12.82	16.34	15.53	15.95	19.67	23.83
100	13.19	16.73	15.93	16.32	20.07	24.17
200	14.71	18.25	17.53	17.76	21.61	25.43
300	16.09	19.53	18.91	19.09	22.96	26.43
400	17.33	20.63	20.10	20.24	23.88	27.21
500	18.43	21.58	21.14	21.24	24.72	27.84
600	19.41	22.42	22.02	22.12	25.43	28.37
700	20.28	23.18	22.82	22.89	26.03	28.79
800	21.09	23.80	23.52	23.56	26.54	29.15
900	21.81	24.38	24.13	24.19	26.98	29.45
1000	22.48	24.90	24.68	24.73	27.37	29.71
1100	23.13	25.37	25.19	25.23	27.72	29.93
1200	23.70	25.81	25.65	25.67	28.03	30.11
1300	24.17	26.20	26.06	26.08	28.30	30.27
1400	24.61	26.56	26.44	26.46	28.55	30.41
1500	25.06	26.90	26.78	26.80	28.78	30.54
1600	25.47	27.20	27.10	27.12	28.98	30.65
1700	25.84	27.48	27.39	27.41	29.16	30.76
1800	26.19	27.74	27.66	27.67	29.33	30.85
1900	26.53	27.98	27.91	27.92	29.48	30.89
2000	26.82	28.20	28.13	28.15	29.62	30.96
2100	27.09	28.40	28.34	28.36	29.75	31.03
2200	27.34	28.59	28.53	28.55	29.87	31.07

TABLE 6

Heat Capacities of the Chloroethenes

Btu./lb.-mole • °R.

°R.	Chloroethene	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Tetrachloroethene
492	12.12	15.55	14.72	15.24	18.84	23.09
500	12.25	15.70	14.88	15.38	19.00	23.24
530	12.56	16.06	15.23	15.69	19.36	23.57
537	12.82	16.34	15.53	15.95	19.67	23.83
600	13.82	17.38	16.59	16.92	20.73	24.72
700	15.28	18.79	18.11	18.53	22.14	25.85
800	16.61	19.98	19.41	19.87	23.30	26.76
900	17.79	21.08	20.54	20.66	24.24	27.48
1000	18.84	21.93	21.52	21.61	25.02	28.06
1100	19.78	22.73	22.36	22.44	25.68	28.55
1200	20.62	23.42	23.11	23.18	26.25	28.94
1300	21.39	24.04	23.78	23.84	26.72	29.28
1400	22.08	24.60	24.36	24.41	27.14	29.56
1500	22.75	25.09	24.90	24.94	27.52	29.80
1600	23.37	25.55	25.38	25.41	27.86	30.00
1700	23.90	25.97	25.82	25.84	28.14	30.18
1800	24.35	26.35	26.22	26.24	28.40	30.33
1900	24.79	26.70	26.58	26.60	28.65	30.46
2000	25.23	27.03	26.91	26.93	28.86	30.59
2100	25.62	27.31	27.22	27.24	29.05	30.69
2200	25.98	27.59	27.50	27.52	29.23	30.77
2300	26.33	27.84	27.76	27.77	29.39	30.85
2400	26.64	28.07	28.00	28.02	29.54	30.93
2500	26.93	28.28	28.23	28.24	29.67	30.99
2600	27.19	28.48	28.42	28.44	29.80	31.04
2700	27.44	28.66	28.61	28.62	29.91	31.09

TABLE 7

Enthalpies of the Chloroethenes

cal./g-mole

°C.	Chloroethene	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Tetrachloroethene
0	0	0	0	0	0	0
18	222.7	285.2	270.4	279.0	344.6	430.8
25	311.7	398.8	378.3	390.0	481.5	586.7
100	1382	1705	1627	1662	2040	2443
200	2962	3656	3518	3572	4325	5094
300	4784	5799	5612	5677	6781	7856
400	6781	8086	7864	7936	9361	10730
500	8915	10490	10240	10320	12030	13650
600	11180	12990	12720	12810	14770	16620
700	13550	15560	15290	15370	17580	19640
800	16010	18220	17920	18010	20430	22670
900	18540	20920	20620	20710	23320	25730
1000	21130	23680	23370	23460	26240	28810
1100	23790	26490	26170	26260	29190	31900
1200	26510	29330	29000	29090	32170	34990

The data of Richards[10] are presented in this paper for chloroethene. Several additional values were calculated for temperatures intermediate between 273.16 and 1500° K. which Richards did not publish.

The spectroscopic data of Thompson and Torkington[22] were used to calculate the heat capacity of 1,1-dichloroethene.

Bernstein and Ramsay[1] published the frequency assignments which were used in the calculation of the heat capacities of both cis and trans-1,2-dichloroethene.

Wu[24] made frequency assignments for the vibrations of trichloroethene. These values give calculated heat capacities which are too low by as much as five calories per mole per degree. Approximate values for the heat capacity were determined graphically by plotting heat capacity versus the number of chlorine atoms in the chloroethene family at lines of constant temperature. A reassignment of frequencies was made which give calculated heat capacities which agree with the graphical values. These calculated values are presented in this paper.

The data of Torkington[22] were used to calculate the heat capacity of tetrachloroethene.

The free energies and heats of formation and heats of combustion are given in Table 2. These values were calculated from the indicated references. Tetrachloroethene is the only compound for which calorimetric data were

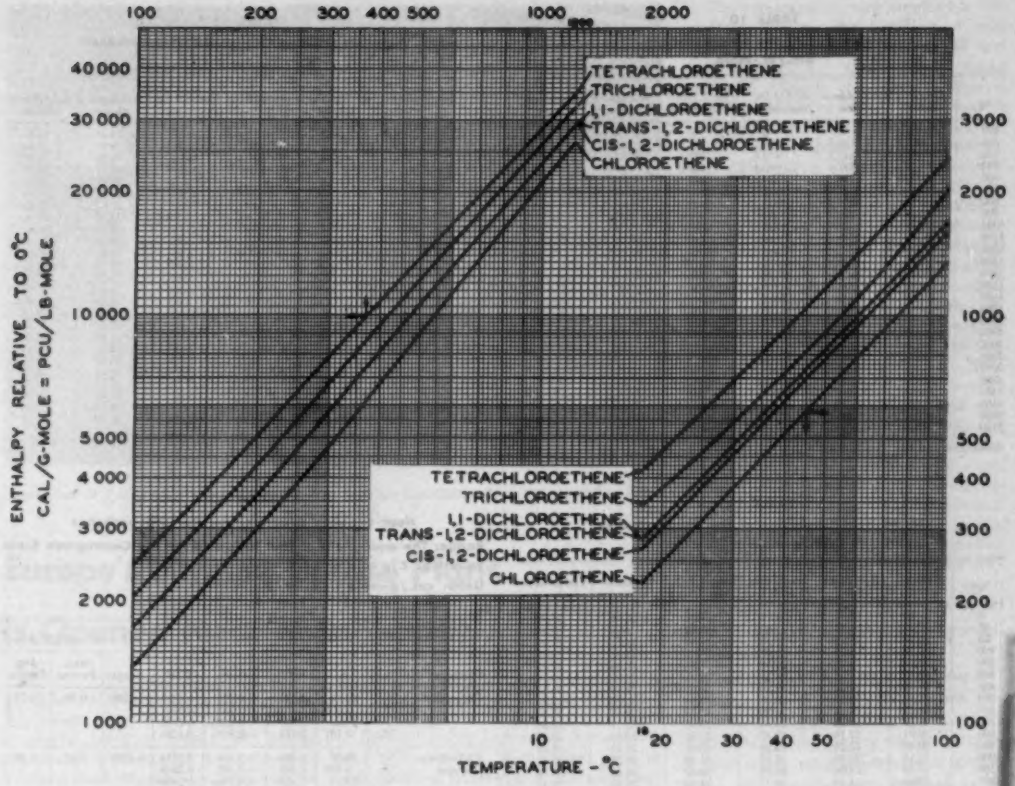

Figure 2. Relative Enthalpies of Chloroethenes.

TABLE 8

Enthalpies of the Chloroethenes

cal./g-mole

°K.	Chloro-ethene	1,1-Dichloro-ethene	cis-1,2-Di-chloroethene	trans-1,2-Di-chloroethene	Trichloro-ethene	Tetrachloro-ethene
273.16	0	0	0	0	0	0
281.16	222.7	288.3	270.4	279.0	344.6	430.6
288.16	311.7	398.8	378.3	390.0	481.5	586.7
300	335.4	428.9	407.0	419.4	517.7	630.6
400	1761	2308	2111	2153	2633	3136
500	3433	4216	4063	4120	4970	5817
600	5304	6400	6203	6270	7463	8617
700	7342	8721	8491	8565	10070	11500
800	9513	11150	10900	10990	12760	14440
900	11810	13670	13400	13490	15520	17430
1000	14200	16270	15990	16079	18340	20450
1100	16680	18940	18640	1873)	21200	23490
1200	19230	21660	21350	21460	24100	26550
1300	21840	24430	24120	24210	27030	29640
1400	24820	27250	26920	27020	29990	32730
1500	27340	30100	29770	29860	32970	35830

TABLE 9

Enthalpies of the Chloroethenes

Btu./lb.-mole

°F.	Chloro-ethene	1,1-Dichloro-ethene	cis-1,2-Di-chloroethene	trans-1,2-Di-chloroethene	Trichloro-ethene	Tetrachloro-ethene
32	0	0	0	0	0	0
40	343.6	442.6	419.8	433.1	533.0	663.4
77	561.1	717.8	680.9	702.0	866.7	1056
100	860.0	1099	1043	1072	1324	1608
200	2256	2850	2717	2778	3411	4092
300	3797	4741	4541	4623	5638	6686
400	5469	6751	6491	6591	7977	9369
500	7258	8862	8556	8686	10410	12120
600	9149	11080	10710	10840	12920	14980
700	11140	13340	12960	13090	15490	17790
800	13210	15690	15280	15410	18120	20690
900	15350	18100	17660	17800	20800	23630
1000	17570	20570	20100	20250	23510	26580
1100	19850	23080	22590	22740	26270	29580
1200	22190	25640	25140	25280	29060	32560
1300	24580	28240	27730	27880	31870	35580
1400	27020	30880	30350	30500	34720	38620
1500	29510	33550	33010	33170	37580	41660
1600	32030	36260	35700	35860	40470	44720
1700	34600	38990	38430	38590	43380	47790
1800	37200	41750	41180	41340	46300	50870
1900	39840	44540	43960	44120	49250	53960
2000	42500	47350	46760	46930	52200	57060
2100	45200	50180	49580	49750	55170	60150
2200	47920	53030	52430	52600	58150	63260

used. The heats of formation of all other compounds were estimated.

The molar heat capacities of the ideal gases on all temperature scales are given in Tables 3, 4, 5 and 6. These data are shown in Figure 1 on the Centigrade and Fahrenheit scales.

The molar enthalpies of the ideal gas, relative to the ice point, 0° C. = 32° F., are presented in Tables 7, 8, 9 and 10 for all four temperature scales. The molar enthalpy in cal./g-mole, or Pcu/lb.-mole, are shown in Figure 2 as a function of the Centigrade temperature.

The mean molar heat capacity above the ice point is given in Table 11 for the Centigrade scale and in Table 12 for the Fahrenheit scale.

Cubic equations to represent the heat capacities of the compounds on all four temperature scales are given in Table 13.

TABLE 10
Enthalpies of the Chloroethenes
Btu./lb.-mole

°R.	Chloro-ethene	1,1-Dichloro-ethene	cis-1,2-Di-chloroethene	trans-1,2-Di-chloroethene	Trichloro-ethene	Tetrachloro-ethene
492	0	0	0	0	0	0
500	101.3	130.0	123.1	127.3	157.3	192.6
520	345.6	442.6	419.8	433.1	535.0	653.4
537	561.1	717.8	680.9	702.0	866.7	1056
600	1404	1179	1698	1742	2146	2596
700	2861	3597	3437	3505	4294	5125
800	4456	5334	5313	5402	6568	7738
900	6177	7360	7310	7415	8947	10470
1000	8008	9738	9413	9531	11410	13250
1100	9940	11970	11610	11740	13950	16080
1200	11970	14280	13890	14020	16540	18950
1300	14090	16650	16230	16370	19190	21870
1400	16240	19090	18640	18780	21890	24810
1500	18480	21580	21100	21250	24620	27780
1600	20790	24110	23610	23760	27390	30770
1700	23150	26680	26180	26330	30190	33770
1800	25560	29300	28770	28930	33010	36800
1900	28020	31950	31420	31570	35870	39840
2000	30520	34640	34080	34250	38740	42890
2100	33060	37360	36800	36960	41640	45960
2200	35640	40100	39540	39700	44560	49030
2300	38260	42870	42300	42460	47490	52110
2400	40910	45670	45090	45250	50440	55210
2500	43580	48490	47890	48070	53390	58300
2600	46300	51330	50720	50890	56370	61400
2700	49030	54189	53560	53750	59350	64500

TABLE 11
Mean Heat Capacities of the Chloroethenes
cal./g-mole · °C.

°C.	Chloro-ethene	1,1-Dichloro-ethene	cis-1,2-Di-chloroethene	trans-1,2-Di-chloroethene	Trichloro-ethene	Tetrachloro-ethene
0	12.12	15.55	14.72	15.24	18.84	23.09
18	12.37	15.84	15.02	15.50	19.14	23.37
25	12.47	15.95	15.13	15.60	19.26	23.47
100	13.52	17.05	16.27	16.62	20.40	24.43
200	14.81	18.29	17.50	17.86	21.62	25.42
300	15.95	19.33	18.71	18.92	22.60	26.19
400	16.95	20.22	19.66	19.84	23.40	26.80
500	17.84	20.98	20.48	20.64	24.05	27.30
600	18.62	21.65	21.20	21.35	24.62	27.70
700	19.36	22.22	21.84	21.96	25.11	28.06
800	20.01	22.78	22.40	22.51	25.54	28.34
900	20.60	23.26	22.91	23.01	25.91	28.59
1000	21.13	23.68	23.37	23.46	26.24	28.81
1100	21.63	24.08	23.79	23.87	26.54	29.00
1200	22.09	24.44	24.17	24.24	26.81	29.16

TABLE 12
Mean Heat Capacities of the Chloroethenes
Btu./lb.-mole · °F.

°F.	Chloro-ethene	1,1-Dichloro-ethene	cis-1,2-Di-chloroethene	trans-1,2-Di-chloroethene	Trichloro-ethene	Tetrachloro-ethene
32	12.12	15.55	14.72	15.24	18.84	23.09
60	12.34	15.81	14.99	15.47	19.11	23.34
77	12.47	15.95	15.13	15.60	19.26	23.47
100	12.65	16.16	15.34	15.76	19.47	23.66
200	13.43	16.96	16.17	16.54	20.30	24.36
300	14.17	17.69	16.94	17.25	21.04	24.95
400	14.86	18.35	17.64	17.91	21.68	25.46
500	15.51	18.94	18.28	18.52	22.24	25.90
600	16.11	19.47	18.86	19.08	22.75	26.29
700	16.68	19.97	19.40	19.60	23.19	26.63
800	17.20	20.43	19.90	20.07	23.59	26.94
900	17.68	20.85	20.35	20.51	23.96	27.21
1000	18.15	21.25	20.76	20.92	24.29	27.46
1100	18.59	21.61	21.15	21.29	24.60	27.68
1200	19.00	21.95	21.52	21.65	24.88	27.88
1300	19.38	22.27	21.86	21.99	25.13	28.06
1400	19.75	22.57	22.19	22.30	25.38	28.23
1500	20.10	22.85	22.49	22.60	25.60	28.38
1600	20.43	23.13	22.77	22.87	25.81	28.52
1700	20.74	23.38	23.04	23.14	26.01	28.65
1800	21.04	23.61	23.29	23.38	26.19	28.77
1900	21.33	23.84	23.53	23.62	26.37	28.89
2000	21.60	24.06	23.76	23.85	26.53	28.99
2100	21.86	24.26	23.97	24.06	26.68	29.09
2200	22.10	24.46	24.18	24.26	26.83	29.17

TABLE 13
Heat Capacity Equations for the Chloroethenes
Range: The equivalent of that indicated for the Centrigrade Scale
Equation: $C^\circ p = a + b(t) + c(t^2) + d(t^3)$
Units: cal./g-mole · °C. or °K.
Btu./lb.-mole · °F. or °R.

Compound	T	a	b·10²	c·10⁵	d·10⁸	Range	ERROR	
							Max. Percent	Avg. Percent
Chloroethene	°C.	12.15	2.919	−2.194	0.6797	0–1200	0.46	0.22
	°K.	2.401	4.270	−2.731	0.6797			
	°F.	11.62	1.665	−0.6894	0.1165			
	°R.	2.401	2.372	−0.8491	0.1165			
1,1-Dichloro-ethene	°C.	15.67	2.835	−2.484	0.8516	0–1200	0.81	0.40
	°K.	5.899	4.383	−3.182	0.8516			
	°F.	15.16	1.625	−0.7808	0.1460			
	°R.	5.899	2.435	−0.9821	0.1460			
cis-1,2-Di-chloro-ethene	°C.	14.80	3.037	−2.659	0.9010	0–1200	0.70	0.39
	°K.	4.336	4.691	−3.397	0.9010			
	°F.	14.25	1.740	−0.8349	0.1545			
	°R.	4.336	2.606	−1.048	0.1545			
trans-1,2-Di-chloro-ethene	°C.	15.30	2.821	−2.375	0.7891	0–1200	0.50	0.27
	°K.	5.661	4.295	−3.022	0.7891			
	°F.	14.79	1.614	−0.7461	0.1353			
	°R.	5.661	2.386	−0.9327	0.1353			
Trichloro-ethene	°C.	19.06	2.777	−2.772	1.010	0–1200	1.17	0.56
	°K.	9.200	4.517	−3.600	1.010			
	°F.	18.55	1.597	−0.8721	0.1732			
	°R.	9.200	2.508	−1.111	0.1732			
Tetrachloro-ethene	°C.	23.30	2.266	−2.434	0.9089	0–1200	0.94	0.42
	°K.	15.11	3.799	−3.179	0.9089			
	°F.	22.86	1.308	−0.7663	0.1558			
	°R.	15.11	2.111	−0.9812	0.1558			

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End of Part XVIII. Part XIX will appear in an early issue.

* * *

Upper Floor of Two Story Filling Building, Showing Multiple Five Gallon Drum Filler and Pint Filler in Background.

Europe's Largest Grease Plant Is Opened Near Manchester

EUROPE'S largest plant, with a capacity to produce 20,000 long tons of several types of grease, and nearly 300 grades of lubricants, was opened at Trafford Park, Manchester, England, on September 25. Shell-Mex and B. P. Ltd., owners and operators of the plant, report that since 1938, England's consumption of refined oil products has doubled from 10 to 20 millions per annum. For lube oils and greases the increase was from 560,000 to 800,000 tons a year. Behind the enterprise are Shell Oil Company and Anglo-Iranian Oil Company, which combined produce 15 million tons of refined petroleum products annually.

On Manchester Ship Canal

Constructed at a cost of $1,400,000, the Shell-Mex and B. P. plant can produce 20,000 tons of grease annually, a tonnage which will be stepped up soon by further mechanization. About three-fifths of the grease is calcium or lime based; the rest is of soda or aluminum base. The calcium based compound is manufactured in an elaborate continuous plant. Heavier production of soda or aluminum base grease can be put into economic manufacture as machinery has been installed to handle such.

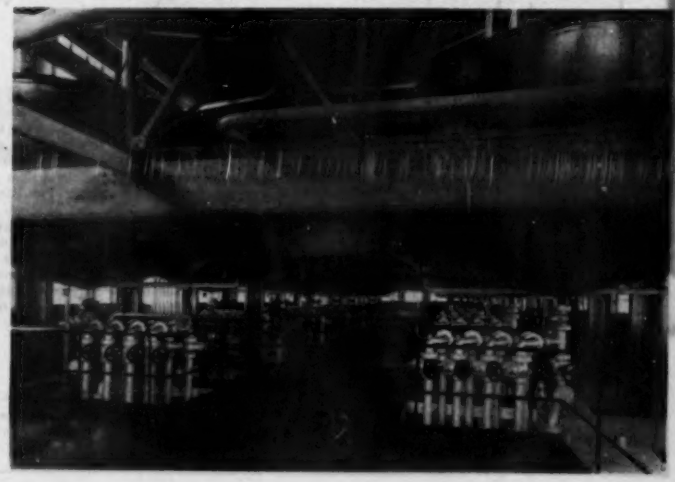
Situated on the Manchester Ship Canal, in the heart of a manufacturing region which contains 50 percent of the British population, the plant has access to ocean vessels and can employ domestic craft for transportation between the parent companies' refineries.

Divided north and south by a road, the northern half of the plant area is essentially a factory area for manufacturing lube oils and greases; the southern part is a 21-million gallon tank farm containing an oil supply depot, with repair facilities for vehicles, and construction and maintenance engineering shops.

The lubricants factory employs a vertical system for the blending of lube oil. It is housed in a building 80 feet high at the roof, containing 30 tanks fed with various components by pipe line from the tank farm. A combination of gravity feed and central control, which has replaced a more dispersed and expensive system of tanks and pumps on one level, comes as near to fully automatic blending as is practicable in a trade which provides a multitude of diverse blends rather than substantial tonages of a few grades. In the blending of different kinds of lube oil the components are fed by gravity into the appropriate tank where thorough mixing is effected; individual tank feed for fats and special additives are raised from the ground floor storage for this purpose. A centralized system of pipe terminals, valves and pneumatic measurements allows a central operator to make simultaneously six blends drawn from a range of close on 50 basic oils or additives. From the lube oil plant most of the blended products are piped to the package plant. The filled and labelled drums and barrels are then taken forward by conveyor to the fork-lift truck operation area, whence they are delivered to storage or sent direct by road, rail or water.

Facilities for blending, packaging and dispatch of lube oils and greases are an integrated part of the factory setup; while the administrative block contains a laboratory, pilot experimental grease plant, etc. Together with the tank farm, the three sections are linked by pneumatic tubes for speedy conveyance of samples, documents; by an internal telephone system, mechanical conveyors, pipe lines, roads, and railways.

Close View of Manifold Floor Showing Distribution Lines to Fillers.



NOMOGRAPH FOR CALCULATION OF YIELD OF POLYMER GASOLINE

(Based on Specific Gravity of 0.700 for the Product)

GEORGE E. MAPSTONE

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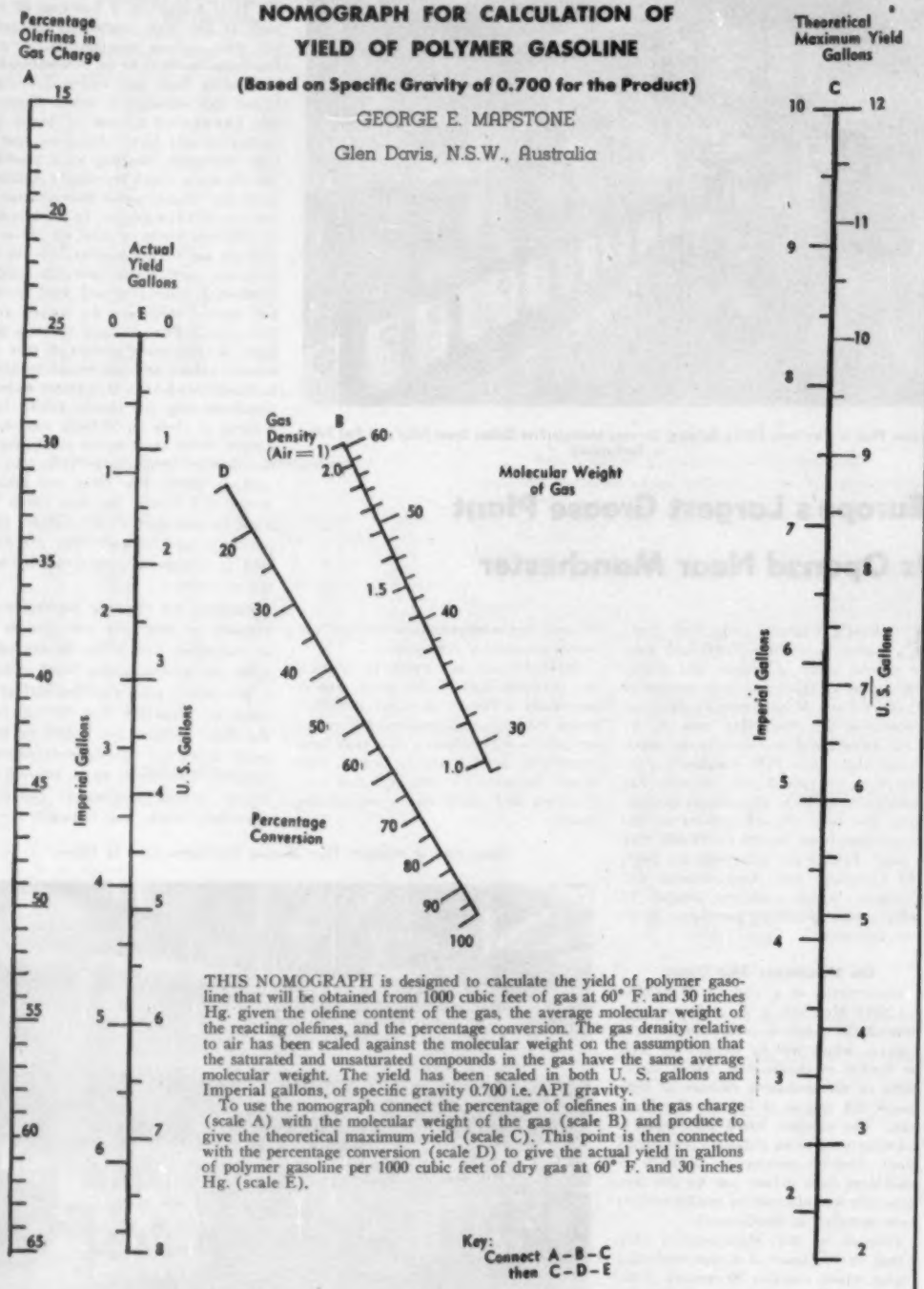
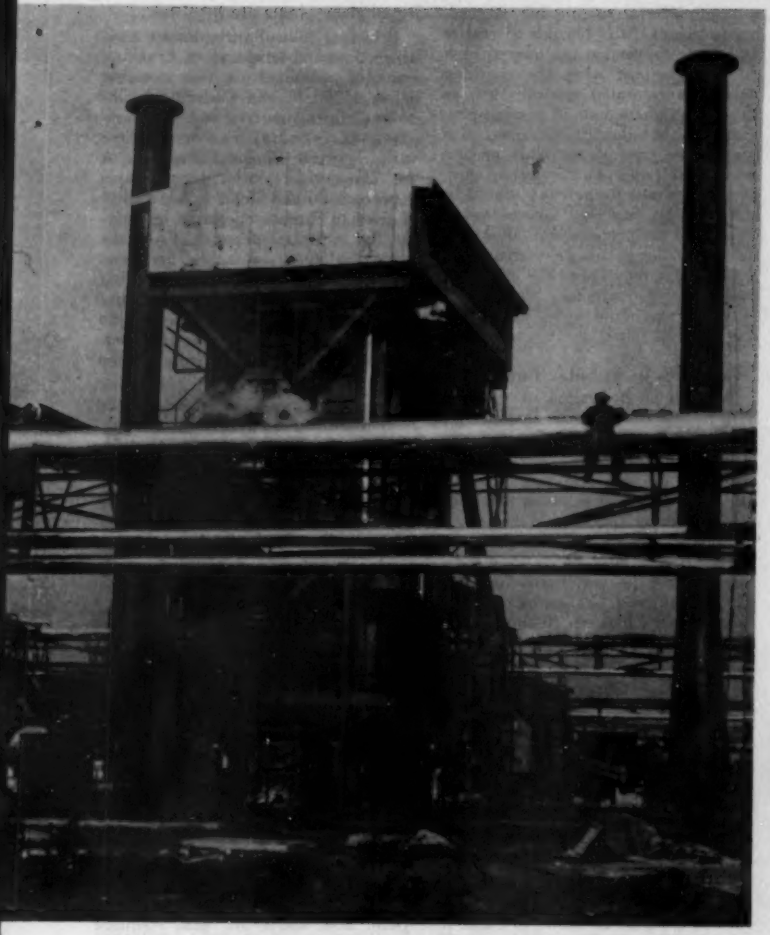


THIS NOMOGRAPH is designed to calculate the yield of polymer gasoline that will be obtained from 1000 cubic feet of gas at 60° F. and 30 inches Hg. given the olefine content of the gas, the average molecular weight of the reacting olefines, and the percentage conversion. The gas density relative to air has been scaled against the molecular weight on the assumption that the saturated and unsaturated compounds in the gas have the same average molecular weight. The yield has been scaled in both U. S. gallons and Imperial gallons, of specific gravity 0.700 i.e. API gravity.

To use the nomograph connect the percentage of olefines in the gas charge (scale A) with the molecular weight of the gas (scale B) and produce to give the theoretical maximum yield (scale C). This point is then connected with the percentage conversion (scale D) to give the actual yield in gallons of polymer gasoline per 1000 cubic feet of dry gas at 60° F. and 30 inches Hg. (scale E).

Key:
Connect A–B–C
then C–D–E



Aromatic Cracking Furnace on Stream (Courtesy, Petrochemicals, Ltd.)

Production of Ethylene From Petroleum Sources

Part II

PETER W. SHERWOOD
Chemical Engineer, Pittsburgh

IN PART I of this series published in September, Peter W. Sherwood reviewed the fundamental knowledge of hydrocarbon pyrolysis in the production of ethylene. Part II now covers the application of laboratory isobaric and isothermal data to commercial operating conditions.

The raw materials for commercial plants may consist of ethane, propane, mixtures of light hydrocarbons, or even gas oil and heavier constituents. The most common conversion method utilizes tubular cracking furnaces. Also, there is considerable new interest in the advantages of other cracking methods, such as Thermofor pyrolysis and partial combustion. This article presents a review of these various processes, together with a discussion of the effect of operating conditions.

Part III will appear in an early issue.

CONSIDERABLE caution must be exercised in the industrial application of fundamental knowledge of hydrocarbon pyrolysis gained in the laboratory and discussed in part I of this article. Isobaric and isothermal conditions, carefully established in the laboratory, cannot be achieved in commercial operation. Moreover, the feed to the pyrolysis furnace is generally quite complex. The plant raw material is dictated by locally prevailing conditions and may vary from a fairly pure ethane or propane stock to mixtures of permanent and L.P. gases and even to the complex hydrocarbon system of gas oil, kerosine, and crude. Even where a fairly pure grade of propane is available as starting material, complexities are introduced into the system by the frequent need for recycling byproduct propylene, butylene, and C_5-hydrocarbons.

For economic reasons, propane and ethane, alone or in mixtures, constitute the most common cracking stock for the production of ethylene. Ethane, which will yield substantially only ethylene and hydrogen in its primary pyrolytic reactions, results in the least complex charge to the cracker, even where recycle operation is practiced. If the pyrolysis is properly controlled,

byproducts such as butylene, etc., formed in secondary reactions, can be kept at an economical expendable level and only unconverted ethane, after separation from the reaction products, need be recycled. As has been pointed out above, the main disadvantages of ethane are its high thermal stability, necessitating very high operating temperatures, and its high cost of shipment by rail or barge, compared with liquefied petroleum gases. Accordingly, ethane cracking is normally confined to plant sites where ethane is available as a byproduct of other operations.

The use of propane as feed stock already introduces complications. Equations (2) and (3) of this article series show that propane pyrolysis can take two different routes, yielding ethylene and propylene, respectively. At the same time, the formation of some ethane is unavoidable, due to the hydrogenation of ethylene or to a limited bimolecular breakdown mechanism:

$$2\,C_3H_8 = 2\,C_2H_6 + C_6H_6 \qquad (10)$$

Secondary reactions forming higher-molecular hydrocarbons take place and become quite significant as the time-temperature reactions in the cracking coil become more severe. It is possible to limit the formation of secondary reaction products by suitable design and operation of the reaction furnace. The ratio of primary products formed according to equations (2), (3), and (10) in purely thermal (non-catalytic) operation is, on the other hand, substantially beyond our control.

In sites where propylene can be used to good advantage for chemical synthesis, propane cracking may serve for the production of both ethylene and propylene. More commonly, however, only one of the two olefins is desired, or the required ratio of these chemicals is not in accord with the output of the cracker. In such instances, it then becomes necessary to separate the product components and to recycle the propylene along with the recovered propane stream. Secondary products: butylene, amylene, and ethane may also be admixed to the cracking stock. This introduces additional complexities in the reaction system. Not only is propylene thermally more stable than propane, but its breakdown products exhibit an even higher degree of unsaturation and are thus even more prone to polymerization and eventual coke formation.

From the point of view of yield and conversion to ethylene, as well as of coke formation, propylene is a raw material inferior to propane. According to Schutt,[1] it is feasible to realize a propane conversion per pass as high as 85-90 percent when the charging stock is a saturated mixture such as 25 percent ethane and 75 percent propane. On the other hand, design of a furnace for cracking a highly unsaturated feed (such as 25 percent propane-75 percent propylene) should be based on an expected conversion of 75 percent for propane and 50 percent for propylene, assuming that byproduct ethane is recycled to the maximum extent. Lower conversion rates are selected if maximum yield is the primary consideration.

Cracking in Tubular Furnaces

Most common method of cracking hydrocarbons to ethylene involves the use of two-sectional tubular furnaces heated by oil or gas.

Design of such ethylene crackers has been discussed in some detail by Schutt.[1] Outlet pressure is chosen by balancing possible yield losses due to secondary reactions at elevated pressures against the cost of recompressing the product gases. Coil outlet pressures vary normally between 10 and 30 psig, with the lower pressure favored for a relatively high-molecular-weight and unsaturated feed. Pressure drop through the coil depends on tube diameter and throughput, and can be estimated by following calculating methods generally employed in the design of vapor phase cracking furnaces.[2,3] In normal practice, the mean operating pressure is some 15 psi above the outlet pressure, i.e., the overall pressure drop through the furnace is about 30 psi. Schutt[1] lists commercial capacities of pyrolysis coils of various diameter as shown in Table A.

TABLE A

I.D. Tube Inch	Reactant Flow Rate (Ethane-Propylene-Propane Charge)	
	Lbs./Hr.	Lbs./Sq. Ft./Sec.
3.0	4,000—5,200	22.5—29.5
3.5	4,800—6,300	20.0—26.5
4.0	5,800—7,800	18.5—25.0

Tube diameter is determined primarily by heat transfer considerations and, to a lesser extent, by pressure drop. In order to maintain the wall temperature of the tube within tolerable limits, high heat transfer rates from metal to gas stream must be brought about by high linear velocities, even at the cost of increased pressure drop through the furnace. A consideration of yields, installation and maintenance costs leads Schutt to recommend 4.5 inches as the maximum tube size to be employed. There is no lower limit to tube size if small capacity ethylene plants are involved.

Principal control variables are residence time and temperature. Cracking rate (of propane) is inappreciable below 1150° F. and the critical conditions are encountered at higher temperatures. Normal residence time varies between 0.7 and 1.3 seconds at the commercial outlet temperatures between 1400 and 1500° F. Flexibility is given to furnace operation by varying the outlet temperature. From the principles discussed in the first part of this article, it is understood that raising the mean reaction temperature (within reason) will decrease the over-all yield but increase the per-pass-conversion and therefore the cracker capacity.

Cracking rate is increased as the temperature in the pyrolysis coil rises. Taking account of the kinetic relationship involved (see Equation 7), it becomes possible to calculate the reaction progress at various points along the tube. For a detailed analysis of this approach to cracker design the reader is referred to Schutt's excellent paper.[1]

Selection of the proper tube metal is critical at the high cracking temperatures involved. Commercial high-temperature steels are limited to operating temperatures not exceeding 1600-1800° F. Most satisfactory from the point of view of high-temperature strength are high chromium alloy steels, notably No. 310 (25/20 chrome-nickel) recommended for temperatures up to 1650° F. Alloys low in chromium and high in nickel content must be avoided because of their tendency to promote the formation of carbon with consequent decrease in yield, and, above all, with resultant reduction in the heat transfer capacity and eventual plugging of the tube.

Control of flue gas temperature at 1750° F. maximum is an effective way of assuring adequate limitation of the critical metal temperature. If this method of control is chosen, flow of

TABLE 1

Pyrolysis of Light Hydrocarbons in Tubular Furnaces[1]

Cracking Stock	Ethane	Ethane	Propane
Coil Outlet Temp., °F.	1425	1475	1435
Pressure, psig.	30.0	15.6	15
Reaction Time, Sec.	1.06	1.5	.....
Conversion, percent	38.5	71.1	.....
Product Distribution—(Vol. percent—Dry Basis):			
H_2	26.0	40.8	9.4
CH_4	2.5	2.9	21.9
C_2H_4	25.5	36.5	19.7
C_2H_6	45.2	17.2	.5
C_3H_6	0.2	0.6	24.5
C_3H_8	.....	0.3	.6
C_4	0.3	0.5	1.7
C_5+	0.1	0.7	10.5

cracking stock and flue gas must be kept co-current.

The injection of small amounts of steam with the cracking stock is recommended to minimize the extent of carbon deposition and especially to reduce corrosion difficulties if sulfur is present in the feed.

Tubular Furnace Performance

Table 1 lists typical commercial tubular pyrolizer performance operating in single-pass operation with a pure ethane or propane charging stock.

As a rough rule, commercial ultimate yields of 75 weight percent ethylene may be obtained in the commercial cracking of ethane. Ethylene yield from propane is 48 percent and from gas oil 25 to 32 percent.

These typical operating figures are, of course, modified by the interrelation between once-through conversion and ultimate yield. Operating at similar conditions and with substantially 100 percent recycle, the Oppau process for the thermal cracking of ethane[4] yields 73.5 percent ethylene with a per-pass conversion of 63.8 percent ethane, compared to a yield of 80.6 percent when the conversion is reduced to 47.5 percent per pass. The adverse effect on over-all yield of raising the once-through conversion is even more pronounced as the molecular weight of the feedstock is increased since here the recycled byproducts (such as propylene) constitute poorer cracking stock than the original feed.

The effect of the different operating variables outlined above is equally noticeable in the manufacture of ethylene as a byproduct of other cracking operation. Thus, in the once-through thermal reforming of a Mid-Continent naphtha at 1160° F., the effect of increasing the pressure from 100 to 300 psi was a marked reduction of olefin yield.[6] The yield of ethylene dropped from 9.68 to 3.36 volume percent of charge, and a similar though less pronounced effect was noted on the formation of propylene and butylene. The reason for this phenomenon is, of course, to be sought in the secondary polymerization and condensation reactions undergone by the unsaturated primary products and favored by elevated pressure.

Conversion to ethylene is favored by setting more drastic operating conditions. Doubling the charging rate resulted in a drop of ethylene yield from 11.5 to 9.68 volume percent (note that this is a once-through operation!). A boost in operating temperature from 1120 to 1160° F. resulted in a yield increase from 6.10 percent to 9.68 percent. This favorable effect of increasing the severity of operating conditions cannot, however, be continued ad infinitum, and a close study of McConnell's data[6] shows that a definite optimum temperature (with regard to ethylene yield) occurs for a number of pressure-charge rate combinations.

Such processes are, of course, operated primarily for the manufacture of a product other than ethylene. Optimum operating conditions for the various main and secondary products do not normally coincide and operation of such plants is generally not attuned to the requirements of maximum ethylene production. By proper control of operating conditions, considerable variation can be attained in the ratio of the plant's products and adjustment can be made from time to time in conformance with the requirements of the market and the production schedule of the adjunct ethylene-consuming chemical plant.

Thermofor Pyrolysis

The major engineering problems encountered due to the high temperatures and relatively large amount of carbon formation in the course of ethylene production by the pyrolysis of hydrocarbons, have led to the application of modified thermofor catalytic cracking units to the process. The thermofor pyrolytic cracking process, developed by Socony-Vacuum Oil Company, Inc.,[7] is reported to offer wide flexibility with respect to charge stock, efficient heat transfer from the primary source to the hydrocarbon being cracked, rapid heating of the hydrocarbon being cracked, continuous elimination of any coke formed in the reactor during cracking and ability to introduce charge stock into the reactor without preheating.

Two primary elements compose the thermofor pyrolytic system: a reaction chamber and a primary heater. The hydrocarbon is introduced into the lower (reactor) chamber where it is contacted countercurrently by highly preheated pebbles. By proper adjustment of reactor volume, pebble level, and flow rate, it is possible to achieve high-temperature contact time compatible with optimum cracking results. Feed may be introduced after a preheating stage or cold, in which latter case the pebbles provide not only the peak temperature heat requirements but the preheating and evaporating functions as well.

The cracked gases leaving the reactor chamber are immediately quenched in order to minimize subsequent yield loss due to polymerization and condensation reactions. The pebbles leaving the bottom of the reactor are lifted to the upper (heater) chamber where they are reheated in direct contact with burning fuel gas. High thermal efficiency approaching theoretical is reported for this stage. Pebble preheat temperatures range above 1500° F. and have reached values as high as 1700° F. in successful pilot plant runs for ethane cracking. Carbon formed in the course of the reaction step is removed from the pebbles in the heating chamber where it serves usefully as supplemental fuel.

Thermofor pyrolytic cracking is particularly promising for the cracking of liquid hydrocarbon stocks in which carbon formation during the pyrolysis becomes a major obstacle to the operation of tubular furnaces (unless large amounts of diluent steam are employed or similar operational modifications are provided).

Selection of operating conditions depends on the feedstock and on the desired plant performance (maximum yield or maximum output). Eastwood and Potas report[7] that pilot plant studies have shown that the limits that usually apply to the operation of thermofor pyrolytic crackers as shown in Table B.

TABLE B

Pebble to hydrocarbon feed ratio, wt.	10—30
Pebble preheat temperature, °F.	1400—1800
Hydrocarbon contact time, sec	0.1—2.5
Pressure, psig	0.5
Steam, weight percent of charge	0—80

Table 2, taken from Eastwood and Potas' work illustrates the performance of a thermofor pyrolytic cracking unit operated on a feed of gaseous hydrocarbons. Cracking temperatures are somewhat higher than is customary in tubular furnace operation since the limitations due to high temperature metal failure are not encountered in this all-refractory reaction system. Process performance is analogous to that of other reaction systems working at similar time-temperature conditions.

Byproducts of Ethylene Production

The yield of ethylene decreases as the molecular weight and the carbon/hydrogen ratio of the feed increase. As has been pointed out above, the principal byproduct of ethane pyrolysis is hydrogen, some methane, and acetylene (the latter especially at very high cracking temperatures). Propane, on the other hand, yields appreciable quantities of ethane and propylene, both of which are more refractory to further conversion than is the primary feedstock. Formation of higher hydrocarbons is unavoidable but quite low in both cases.

Cracking of liquid petroleum frac-

TABLE 2

Performance of Thermofor Pyrolytic Cracking Units[1]

TPC Cracking of Light Hydrocarbons for Ethylene Production.

Type of Operation	Once Through Cracking			Recycle Cracking	
Charge Stock	Ethane		Propane	Mixed Light Hydrocarbons	
Composition, percent weight:				Fresh Feed	Recycle
Methane + hydrogen	99+		99+	0.8	
Ethane				40.8	63.1
Propane				40.0	14.4
Propylene				16.0	22.2
C_4's				2.4	
Total				100.0	100.0
Pebble preheat temperature, F	1525	1770	1510	1500	
Contact time, sec	2.3	0.12	1.2	1.7	
Recycle to fresh feed ratio, wt				1.0	
Yields, Percent Wt. on Charge:					
Hydrogen	5.7	5.7	2.0	3.2	
Methane	12.8	10.2	36.2	23.2	
Acetylene	0.7	3.8	0	0	
Ethylene	49.2	56.2	37.5	62.0	
Ethane	18.2	11.6	3.5		
Propylene	0.7	1.0	12.2		
Propane	1.1	0.7	7.9		
Butadiene	1.6	3.2	2.3	0	
Butylenes	1.8	0.4	1.1	3.0	
Butanes	1.0	0.3	0	2.0	
C_5+	6.7	6.1	6.8	5.0	
Coke	0.5	0.8	0.5	1.6	
Total	100.0	100.0	100.0	100.0	
Ethylene concentration in C_2 and lighter, mol. percent	29.0	33.3	22.7	30.1	

TABLE C

Hydrogen	27.0
CH_4	8.0
C_2H_2	0.5
C_2H_4	31.0
C_2H_6	17.0
C_3+	2.5
CO	11.0
CO_2	1.4
O_2	0.6
N_2	1.0
	100.0

tions and crudes results in the formation of appreciable quantities of by-product olefins, dienes, and cyclical compounds. The best ethylene yields from petroleum crudes are derived from highly paraffinic feedstocks and do not exceed 30 percent, while more aromatic raw materials may limit economically feasible ethylene production to 12-15 percent (weight basis).

Aside from the simultaneous formation of some hydrogen, and light hydrocarbons, the bulk of the byproducts derived from the pyrolysis of liquid hydrocarbons is an oil, the aromaticity of which increases with the severity of the cracking conditions. The gasoline fraction obtained is characterized by very excellent octane numbers and may in fact serve as raw material for the commercial recovery of benzene, toluene, and xylenes, while the higher liquid fractions will yield naphthalene and its alkylated derivatives in commercially attractive quantities.

The highly aromatic nature of the byproduct liquids prevents their satisfactory use as recycle stock or as charging stock to most cracking processes. Beyond their possible utilization as chemical raw material, they must therefore serve as fuel oil or, possibly, as charging stock to high-pressure hydrogenation by which process they may, of course, be reconstituted as satisfactory raw material for ethylene (or gasoline) production.

Partial Combustion Process

Ethylene production by the partial combustion of ethane is an alternative way of circumventing the engineering difficulties inherent in the construction of the high-temperature tubular furnaces required for ethane pyrolysis. Success of the process depends on the availability of a cheap source of oxygen and this approach is not in any case considered suitable for the present American economy where fuel gas or oil for firing cracking furnaces is available at a relatively low price. Partial combustion has been practiced on a commercial scale (13,000 tons ethylene per year) at the Leuna (Germany) plant of I. G. Farbenindustrie. This is believed to be the only commercial plant which has so far been operated by this process.

Partial combustion of ethane is carried out in a once-through operation. Three volumes ethane and one volume oxygen (Linde-Frankl purity) are preheated separately to 1100-1200° F. and 750° F., respectively. The hot gases pass to a high-efficiency mixer in the bottom of the cracking chamber. The gas mixture passes upwards through the reactor which is filled with 1¼-inch diameter ceramic spheres. Maximum temperature in the cracker is 1620° F. A partial vacuum of 3-400 mm. Hg absolute is maintained. The cracked gases are cooled to 570-750° F. by indirect heat exchange in a tubular heat exchanger, and are finally cooled to room temperature in direct contact with water. Ethylene yield is 60-65 percent of theory.[8] A typical cracked gas analysis, characterized by high carbon monoxide content, is reported by Holroyd[9] as shown in Table C.

The cooled cracker gases must be submitted to a caustic wash because of the presence of small amounts of organic acids and formaldehyde.

End of Part II. Part III will appear in an early issue.

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REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the processing industry.

Roland Harrison | D. F. Othmer | Roger Gilmont | H. E. Degler | John C. Maher

Lecturers Prove Apt With Written Word, Too

Dr. Donald Frederick Othmer once formed a partnership with a "man named Smith," but this month he collaborates with Dr. Roger Gilmont on an article titled: "Correlating Physical and Thermodynamic Properties Used in Petroleum Technology" which appears on page 111.

Dr. Othmer is a much traveled chemical engineer who has been employed by firms in Canada, Sweden, Spain, France, England, Belgium, Switzerland, Italy, India, South Africa, the Orient and Philippines, Mexico and the three Americas. He has also been called upon for consultation and service by most military departments of the U. S. government as well as various other civil branches.

Holder of over 75 U. S. and foreign patents on methods, processes and engineering equipment, co-inventor of Smith-Othmer wallboard made from wood and other cellulosic wastes, co-editor of the Kirk-Othmer, Encyclopedia of Chemical Technology in twelve volumes, and also contributor of over 150 articles to technical journals at home and abroad, Dr. Othmer has found time to make extensive lecture tours since 1948.

Dr. Othmer took his M.S. and Ph.D. at the University of Michigan. He is a member of so many technical and other organizations it would prove impractical to list them here.

Co-author Dr. Roger Gilmont joined the New York scene during the turbulent days of 1916, and during his school days won many scholastic honors in mathematics, physics, and chemical engineering. In 1943 he took his M.S. in chemical engineering from Brooklyn Polytechnic Institute and subsequently his Ph.D. in 1947.

Since 1947 he has been the technical director in charge of the Technical and Engineering Department at the Emil Greiner Company in New York. As such he concentrates on research and development of new laboratory and chemical engineering instruments, as well as design of laboratory and pilot plant equipment for company clients. Patent rights, publication releases and reports for the department are part of his routine. Concurrently, he has taught in the chemical engineering department of Polytechnic Institute of Brooklyn since 1949.

June Bridegroom Supplies Kobe With Calculations

Roland H. Harrison, co-author with Dr. Kenneth A. Kobe of "Themochemistry for the Petrochemical Industry, Part XVIII," which appears on page 151, is a graduate student in the Department of Chemical Engineering at the University of Texas. He was recently awarded the Carbide and Carbon Chemicals Fellowship in Chemical Engineering for the year 1951-52. During 1950-51 he held The Dow Chemical Fellowship in Ch.E.

The U. S. Army "greeted" Harrison during his second year at the University of Texas, and he spent a year in Army training before returning to school. Granted an undergraduate degree in chemical engineering in 1949, he entered graduate school where he added statistical and quantum mechanics, and advanced mathematics to his regular course. High scholastic rating elected him to Omega Chi Epsilon, Tau Beta Pi, and Phi Lambda Upsilon.

Married to Miss Mary Margaret Fewell of Austin in June, the flustered bridegroom collected himself sufficiently to qualify for admission to candidacy for a Ph.D. degree during the summer. He is working on calculations on the thermodynamic properties of ammonia to complete his Master's thesis. Harrison's hobbies are photography and square dancing.

Dr. Kobe, prime author of the present series, is well known to PR readers as he has been a popular contributor for years.

Geologist Relates Ground Water to Oil

Geologist John C. Maher, author of "Ground Water with Reference to the Oil Industry," found on page 101, has been hard at it since 1936 when he became part of the geological work being done by the Nebraska Geological Survey. Prior to employment with the Survey, he was a student at the University of Nebraska, receiving an A.B. in 1935 and M.Sc. in 1937. Following graduate work at Louisiana State University, he worked a year with the Shell Petroleum Corporation at Tulsa before becoming a member of the U. S. Geological Survey in 1938.

Within that organization he served as District Geologist for the Ground Water Branch in Louisiana, supervising groundwater exploration at Camp Claiborne, Camp Livingston, Camp Polk, Alexandria, and Natchitoches. In 1944 he was transferred to Tulsa and given the appointment he holds at the present time of supervising geologist, Fuels Branch.

Among his publications on water-supply are several Louisiana Geological Survey bulletins and pamphlets, U. S. Geological Survey Water-Supply Papers, and numerous articles in technical journals. He also authored several reports on surface and subsurface petroleum geology in Arkansas, Kansas, Colorado, and the Oklahoma Panhandle.

Technical Director Is Veteran Professor

Author or co-author of several textbooks on gas, oil and steam power, Howard E. Degler this month makes an initial contribution to PETROLEUM REFINER entitled, "Selection and Operation of Water-Cooling Towers and Air-Cooled Heat Exchangers," on page 145.

Degler joined the Marley Company as technical director in January, 1948, as a veteran of 17 years as chairman of the mechanical engineering department at the University of Texas. His teach-

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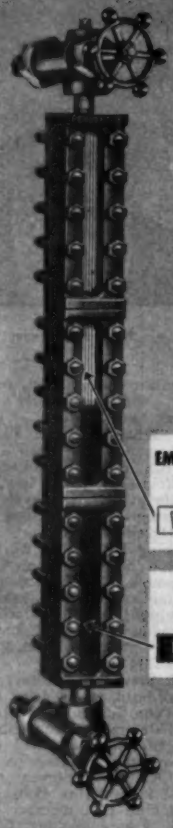

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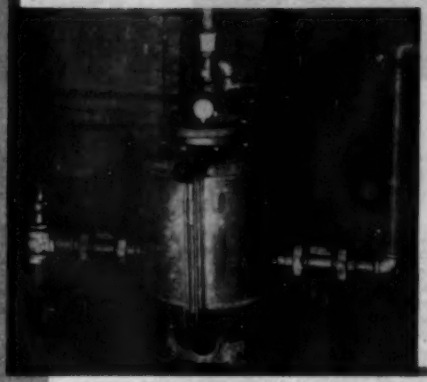

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T. S. Peterson | G. W. Schall | D. H. Stevenson | Heinz Heinemann

ing and chairmanship tenure at the University was broken only by a twelve month tour with the U. S. Army Information and Education Division beginning July, 1945.

A mechanical engineering graduate of Lehigh University, and a M.S. graduate of the University of Illinois where he served on the mechanical engineering department faculty for eight years, Degler has had industrial experience with such companies as Babcock & Wilcox, General Electric, Bethlehem Steel, Atlantic Refining, and Sargent & Lundy. He has conducted research and consulting work in heat power, gas and oil engines, refrigeration, and air conditioning.

Peterson's Text Was Address Before CNGA

T. S. Peterson, one of many company principals steering his company through the long-drawn-out anti-trust suit by the government, is the author of "Natural Gasoline and Petroleum Progress" on page 89. This is the text of a paper delivered to the CNGA.

President of the Standard Oil Company of California, Peterson began his career with the company in 1922 at Portland, Ore., and was identified with marketing activities for a long while. By 1938 he had been appointed manager of the Employe Relations and Personnel department, and later was named general manager of sales. Elected to the board in 1942, he has been connected with general administration since.

Gives Bomb Data

Robert C. Wing, article on page 99, is on the staff of the Chief of Naval Operations as management control officer of Pacific Bases. He has served extensively on advisory petroleum committees, but also has seen sea duty on destroyers and destroyer escorts. A member of the bar in Maine and Virginia, he holds graduate degrees from George Washington University, Harvard, and Annapolis. Civilian experience includes time with Standard Oil Companies of New Jersey and Ohio.

Houdry Contributes Three Authors to PR

Three staff members of Houdry Process Corporation pooled their knowledge and experience for the article, "Application of Houdriforming to Production of Aromatics and High Octane Motor Gasoline," on page 107.

Well known throughout the industry as PETROLEUM REFINER's patent digest editor, **Dr. Heinz Heinemann,** is a well known author whose last previous PETROLEUM REFINER contribution was entitled "Petroleum Type Hydrocarbons from Sugar Cane," February, 1950. Perusal of this month's Patent section will reveal that Dr. Heinemann has just received a new set of patent rights to add to his growing patent credits.

A native of Germany, he completed formal studies at the University of Berlin, at Technische Hochschule, Berlin, and at the University of Basle, Switzerland, where he received a Ph.D. in 1937 upon completing a thesis entitled: "On the Ignition Tendency of Brown-coal Diesel Fuels." Dr. Heinemann's research career since then has been chiefly in the field of catalytic refining. After a year's research work on synthetic fuels in Germany, he came to the U. S. as chief research chemist for the Rodessa Oil & Refining Corporation at Shreveport in 1938. Two years later he became research chemist for Dancinger Oil & Refining Inc., at Tulsa, operating their Pampa, Texas, refinery. In 1941 he was named research-fellow at Carnegie Institute of Technology and served as assistant to the late Dr. Ernst Berl.

He joined Houdry as a project director in January, 1949, after serving as research chemist and research supervisor with Attapulgus Clay Company, Camden, N. J. At the present time he serves as section leader in charge of Process Research. In spite of many publication commitments, he still finds time to devote to redecorating, gardening, etc., at his home in Swarthmore, Pa. Married, he and his wife have two children, three years and six months of age. "What time is left" after preparing the patent digest each month for PETROLEUM REFINER, is given over to such hobbies as music appreciation, reading, photography, and particularly home movies of his two children.

Josef W. Schall, born in Philadelphia, and a graduate of both Lehigh University (B.S. in Ch.E.), and the University of Rochester (M.S. in Ch.E.), joined Houdry in 1944 as a development engineer. Currently he is section leader of Process Development.

Before joining Houdry he worked in the production department of Calvert Distilling Company as production planner and administrator. He makes his home at Springfield with his wife and two sons, aged eight and one-plus. Schall's hobbies include sports, gardening and duplicate bridge.

Donald H. Stevenson, another Philadelphia native-born, received his B.S. in Ch.E. from Penn State in 1948. He went on to immediate employment with Houdry and is presently assigned to the Process Development Section. A junior member of A.I.Ch.E., Stevenson is a bachelor and takes figure skating seriously. In fact he is a member of the International Figure Skating Club of Philadelphia.

Ex-Professor Zurcher Turns to Consulting

Paul Zurcher this month continues his Notes On Dewaxing on page 121. A fervent adherent of severe physical exercise, he indulges in walking, horseback riding or swimming regularly. A Swiss by birth, he graduated from the Federal Polytechnical School in Zurich, receiving cash and a silver medal for his thesis on electrochemistry. For a while he lived a wanderer's life, working in Italy, France, Bolivia, and Colombia, concentrating on ceramics, metallurgy of tin, gold and silver, and in industrial development.

In 1915 he came to the U. S. and subsequently worked for Continental Oil Company until 1946. In January, 1947, he joined the staff of the University of Tulsa to teach petroleum refining and supervise graduate work. Since then he has quit the University to devote all his time to consulting work.

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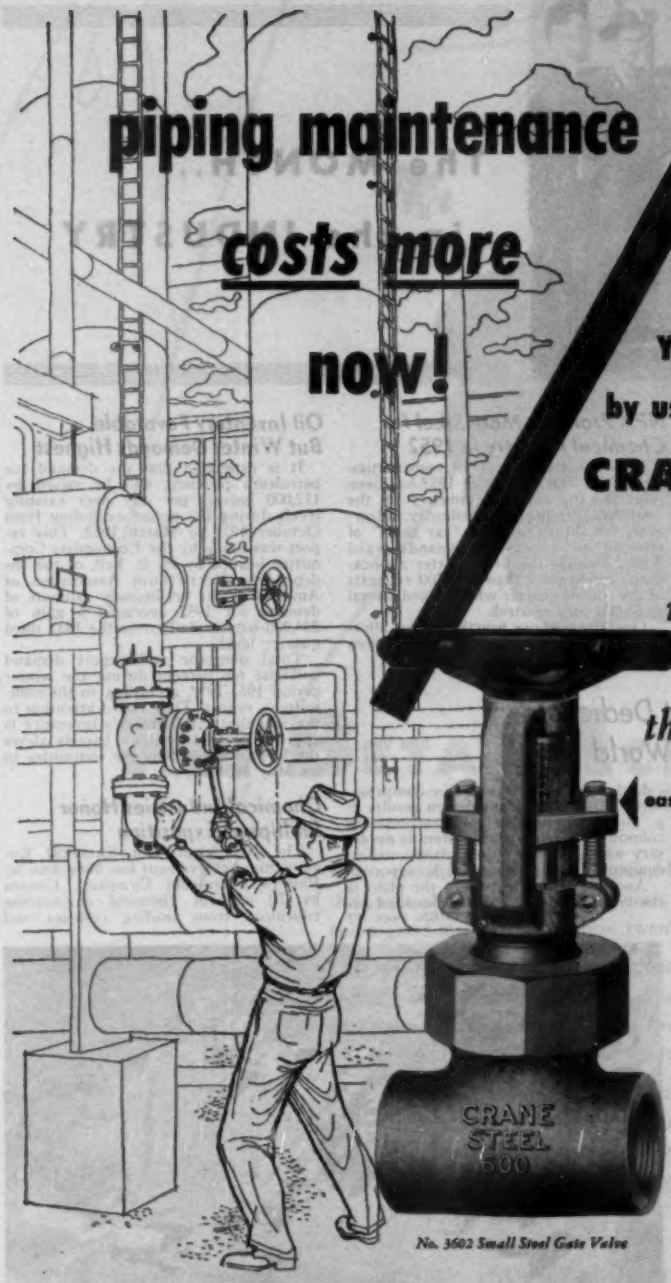

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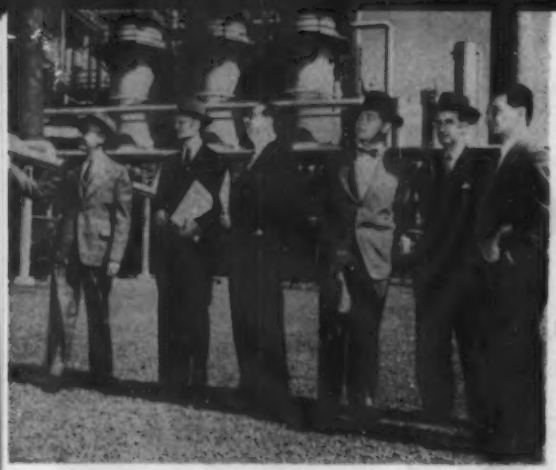


FRENCH OBSERVERS studied the Sun Oil Company refinery at Marcus Hook, Pa., recently seeking ways to improve gas production in their own locality. Sponsored by the French Government-Economic Corporation Administration, they showed particular interest in the results of Sun's catalytic cracking operations. In the group shown are, left to right, C. C. Naylor, operating special assistant of Sun; Antoine Bolzinger, consulting engineer of Gaz de France, Paris: Jean Penaud, inspecting engineer of Gaz de France, Bordeaux; Charles E. Maschal, refinery manager for Sun; Bernard Coussy, engineer of Gaz de France, Paris; and Jean Echard, chief engineer, gas division of the Ministry of Industry & Commerce, Paris.

The MONTH... in the INDUSTRY

NPA Promises More Steel for Chemical Industry in 1952

More structural steel for construction during the first quarter of 1952 has been promised the chemical industry by the National Production Authority. However, the supply will fall "far short" of meeting all expansion demands, said NPA, because the first quarter applications are heavier than the 700 requests of the fourth quarter which asked a total of 56,000 tons of steel.

Operators whose fourth quarter allotments were not sufficient will be given first call on forthcoming supplies.

Oil Inventory Favorable But Winter Demands Highest

It is estimated that the demand for petroleum products will be raised by 172,000 barrels per day over existing levels during the period extending from October 1951 to March 1952. This report was made by the Economists Committee headed by H. B. Fell, of the Independent Petroleum Association of America. Their preliminary estimate of demand for 1952 averaged a gain of 234,000 barrels daily over the 1951 third quarter level.

Total domestic and export demand will rise 6.6 percent during the winter period 1951-1952, according to the committee's report. They called attention to the fact that the industry's inventory is approximately 13 million barrels above the level estimated by the committee in its May 1951 report.

Chemical Industries Honor Phillips at Exposition

The 1951 award for Chemical Engineering Achievement has been won by Phillips Petroleum Company. Chosen by 70 eminent chemical engineering educators from leading colleges and

West Texas Gasoline Plant Dedicated As Possibly Largest in the World

Possibly the largest plant in the world, as measured by the total of liquid hydrocarbons produced from casinghead gas from oil and gas producing structure, was dedicated October 24 when West Texas held open house at the recently completed Snyder gasoline plant. Public inspection of the $8-million natural gas conservation project, operated by Sunray Oil Corporation for some 30 companies and 60 individuals who own the project, was featured by an address by the Hon. Olin Culberson, Austin, chairman of the Railroad Commission of Texas.

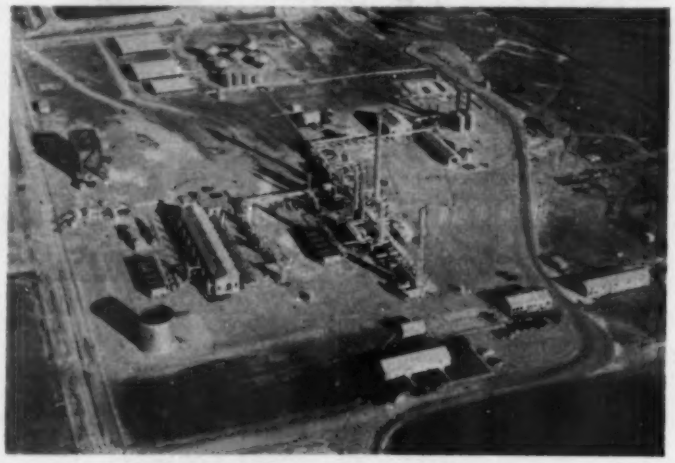
Although the plant is still undergoing processing tests, more than 473,000 gallons of liquid products were produced in one 24-hour period while processing approximately 50-million cubic feet of gas per day. The plant is designed ultimately to handle approximately 65 million cubic feet per day of gas and to produce approximately 500,000 gallons per day of liquid products when at peak production.

Liquid products produced are propane, normal butane, isobutane, and various vapor pressure natural gasolines. Products are moved from the plant by tank car and tank truck. All residue gas remaining after extraction of liquid hydrocarbons is treated for the removal of undesirable constituents, and is sold to gas pipe line companies who have pipe line connections to the plant.

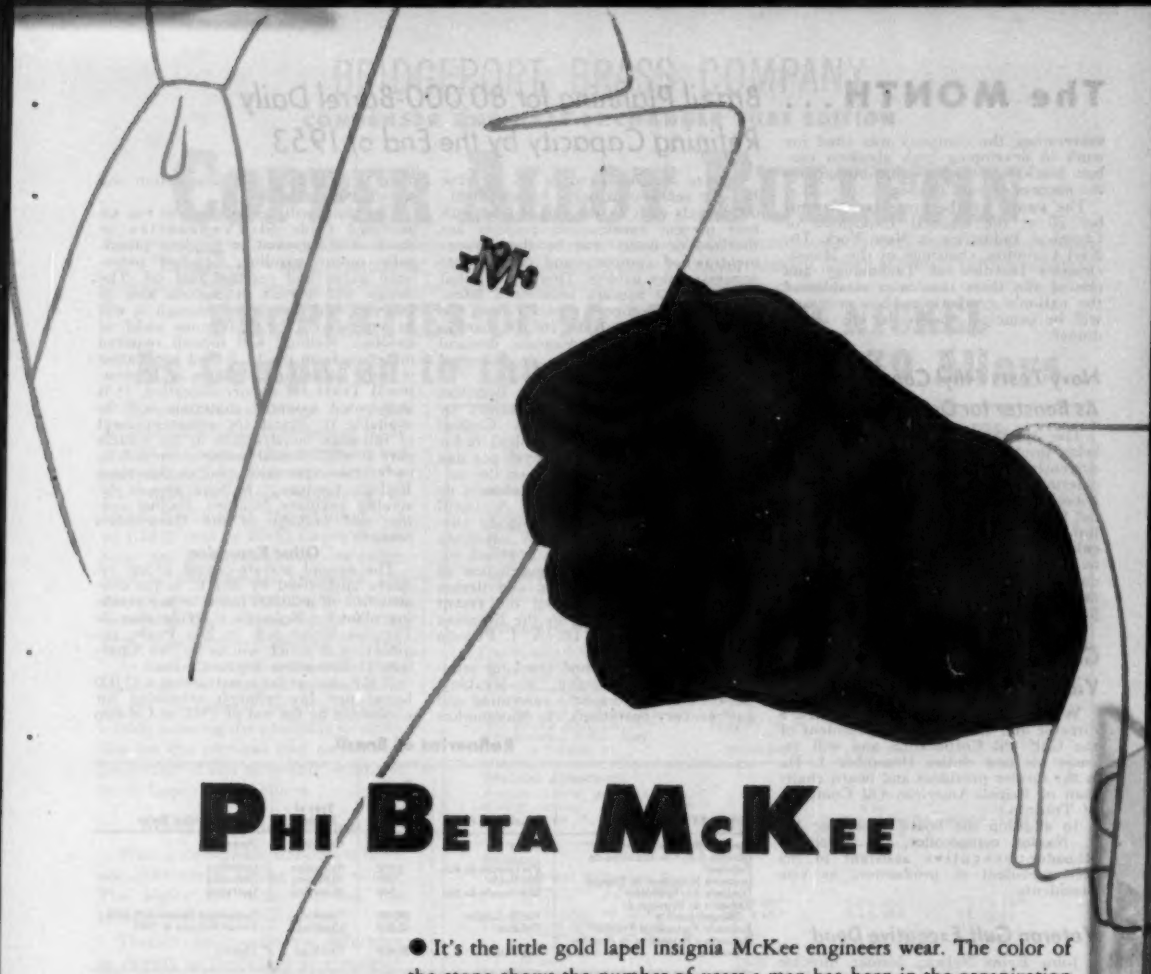
The most significant and unusual feature of this new plant is the deethanizing absorber into which the compressed gas is discharged after leaving the compressors. This unique plant design results in a minimum number of fractionating columns. No reabsorber system is necessary which further reduces fractionating equipment and compressor horsepower.

Another unique feature of the plant is the underground storage of liquefied pe-

• See SNYDER, page 172



Airview of new Snyder gasoline plant.



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The MONTH . . .

universities, the company was cited for work in developing high abrasion carbon black, and major contributions to the success of cold rubber.

The award will be presented November 28 at the biennial Exposition of Chemical Industries in New York. Dr. Karl Compton, chairman of the Massachusetts Institute of Technology and one of the three men who established the nation's synthetic rubber program, will be principal speaker at the award dinner.

Navy Tests Ethyl Compound As Booster for Diesel Fuel

The special blend of amyl nitrates being produced by Ethyl Corporation is currently being tested by the Navy to determine if the blend will boost regular Diesel fuel to Navy specifications without further refining. If Navy hopes materialize, refiners will be able to meet enlarged defense demands without strain on their capacity and facilities. Varying quantities of the new compound may produce uniform Diesel fuel levels thus promoting uniform engine design.

Gulf Oil Elects Three New Vice Presidents to Office

William K. Whiteford was elected a director and executive vice president of the Gulf Oil Corporation and will assume his new duties December 1. He is the former president and board chairman of British-American Oil Company of Toronto.

In addition the board appointed W. L. Naylor, comptroller, and Ralph O. Rhoades, executive assistant to the vice president of production, as vice presidents.

Veteran Gulf Executive Dead

John Evon Nelson, former director and executive vice president of Gulf Oil Corporation, died at his home last month. He retired June, 1949.

Brazil Planning for 80,000-Barrel Daily Refining Capacity by the End of 1953

Strides are being made to increase Brazil's refinery capacity by about 80,000 barrels daily by the end of 1953 with four present construction projects authorized or under way by the government-owned company and two private concessionaire groups. This is the initial phase of the nation's announced intention to boost refinery capacity from the present 4000 barrels to 160,000 barrels per day to cover its domestic demand and eliminate dependence on imported refined products.

The first of the two private Brazilian capital refinery projects authorized by Brazil's National Petroleum Council (Conselho Nacional de Petroleo) is for the erection of a 10,000 barrel per day plant in the Federal District on the outskirts of Rio de Janeiro by Refinaria de Petroleos de Manguinhos S. A. (until recently Refinaria de Petroleo do Distrito Federal). The M. W. Kellogg Company, which won the contract for design and supervisory construction of this plant, has engineering and design work under way following the recent completion of financing by the Brazilian company, headed by Dr. A. J. Peixoto de Castro, Jr.

A single unit thermal cracking refinery combining topping, vis-breaking, gas-oil cracking, naphtha reforming and gas recovery operations, the Manguinhos plant is scheduled for completion the second half of 1953.

The plant will be designed to run on imported crude oil--Venezuelan or Saudi Arabian—and to produce principally motor gasoline, liquefied petroleum gases and residual fuel oil. The design will permit production also of kerosine and diesel fuel, though it will be engineered for maximum yield of gasoline. Kellogg will furnish required materials from the U. S. and application is being made to the Office of International Trade for export allocation. It is anticipated essential materials will be available in Brazil for commencement of full-scale construction in the middle part of 1952. Actual construction will be under the supervision of Pan American Kellogg Company. Kellogg also is designing auxiliary facilities, cooling system and tankage of the Manguinhos refinery.

Other Expansion

The second private-capital group refinery authorized by N.P.C. is for construction of a 20,000 barrel a day cracking plant by Refinaria e Exploracao de Petroleo Uniao S.A. at São Paulo, engineering of which will be by Pan American Hydrocarbon Research, Inc.

N.P.C. has under construction a 45,000 barrel per day refinery, scheduled for completion by the end of 1953, at Cubatao in the Santos-São Paulo area. It has also awarded a contract to Kellogg for doubling the capacity of the 2500 barrel-a-day Mataripe (Bahia) refinery which completed its first year of operation in October.

The authorization of the two privately-owned refinery projects culminates the invitations by National Petroleum Council in late 1945 to Brazilian capital to bid on refining concessions. Under the 1938 and subsequent decrees of the earlier regime of Dr. Getulio Vargas (who again is president) the Brazilian petroleum industry was nationalized and participation—except for marketing—is limited to the government and to corporations composed entirely of native-born Brazilian shareholders. N.P.C. is the only entity engaged in exploration for and production of crude oil. Its current output averages 2500 barrels daily, or about the capacity of the N.P.C.-owned Mataripe refinery, from five fields in Bahia state.

The remainder of the total Brazilian petroleum demand averaging about 95,000 barrels daily is filled by imported refined products of about 92,000 barrels daily and crude imports of about 2000

Refineries of Brazil

COMPANY	Location of Plant	Crude Charging Capacity B/D	Type of Refinery	Operating Status
Conselho Nacional de Petroleo[1*]	Bahia	2,500	Cracking	Operating
Ipiranga S.A. Cia. Brasileira de Petroleo[2]	Rio Grande do Sul	1,000	Skimming	Operating
Industria Matarazzo de Energia	São Paulo	200	Skimming	Operating
Distilaria Rio Grandense	Rio Grande do Sul	300	Skimming	Operating
Refinaria de Petroleos de Manguinhos S.A.	Rio de Janeiro	10,000	Cracking	Completion Second half 1953
Refinaria Nacional de Petroleo*	Cubatão	45,000	Cracking	Completion end of 1953
Refinaria e Exploracão de Petroleo Uniao S.A.	São Paulo	20,000	Cracking	Planned

* Government-owned plants.
[1] Expansion underway to 5,000 barrels daily total capacity.
[2] Expansion to 2,000 barrels daily authorized.

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gas-oil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1950:									
January 28	4,956	5,479	248,411	18,363	124,270	7,202	66,337	8,386	37,038
February 25	5,000	5,377	248,580	17,708	123,383	p 6,920	56,056	7,955	48,563
March 25	4,945	5,409	244,227	17,529	135,406	6,870	60,377	8,171	42,546
April 29	5,014	5,314	244,744	18,030	129,655	6,531	56,586	7,272	39,260
May 27	5,118	5,591	240,842	18,704	122,757	7,201	60,607	7,421	39,306
June 24	5,358	5,636	240,762	19,626	115,036	6,866	50,580	7,461	41,291
July 29	5,522	5,870	240,226	19,981	109,076	7,266	61,437	7,870	42,252
August 26	5,699	6,197	236,934	20,263	105,793	7,559	65,841	8,543	41,697
September 30	5,903	6,051	241,631	19,524	104,303	8,460	76,734	8,306	42,320
October 28	5,985	6,051	244,808	19,575	105,062	8,259	84,057	8,449	44,310
November 25	5,888	6,238	244,497	19,847	106,424	8,591	86,768	8,470	45,566
December 23	5,763	6,189	250,798	20,075	112,631	9,436	73,273	8,715	39,914
1951:									
January 27	6,066	6,482	244,230	21,106	126,261	9,954	58,997	9,906	40,378
February 24	5,954	6,524	237,204	20,815	136,870	10,545	49,764	9,471	39,995
March 31	6,041	6,391	235,566	20,596	142,188	9,365	43,170	9,147	37,282
April 28	6,154	6,236	242,479	19,876	137,474	8,061	43,859	8,747	36,080
May 26	6,166	6,430	246,400	21,102	130,810	8,580	51,344	9,045	37,365
June 30	6,151	6,506	247,299	21,666	126,844	8,542	65,700	9,036	41,097
July 28	6,206	6,394	241,203	21,530	121,156	8,174	76,928	8,856	44,957
August 25	6,220	6,508	232,267	21,502	115,934	8,761	86,543	8,762	46,763
September 29	6,303	6,556	255,819	21,095	112,356	9,124	97,019	8,322	47,569
October 27	6,340	6,461	258,308*	22,364	111,120	9,380	102,106	8,433	49,168

* Stocks October 20.

BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND. — IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

PROPERTIES OF 90-10 CUPRO NICKEL As Compared to the 80-20 and 70-30 Alloys

Government restrictions for nickel often require the replacement of 80-20 and 70-30 Cupro Nickel condenser and heat exchanger tubing with 90-10 Cupro Nickel or alloys containing no nickel. Fortunately, the addition of 1 to 1.75% iron to 90-10 Cupro Nickel alloy has greatly improved its resistance to impingement corrosion and general corrosion from saline cooling waters, so that it compares favorably with 70-30 cupro containing 0.5% iron.

In answer to many requests for data regarding the physical properties of 90-10 Cupro Nickel, we have compiled a table covering the available information on the physical and mechanical properties of this alloy and 70-30 and 80-20 Cupro Nickel alloys.

Effect of Nickel Content

From a mechanical standpoint there are differences among these alloys. The higher the nickel content, the stronger and harder the alloy.

There is no appreciable difference in density or coefficient of expansion among all three. However, there is a considerable difference in thermal conductivity, with the 90-10 alloy being about 50% higher than the 70-30. The same is true for the thermal capacity. The thermal differences are not significant in affecting heat exchanger design, as recognized by those most familiar with the calculation and measurement of heat transfer rates.

There is some difference in electrical resistivity or conductivity which is significant in resistance welding techniques. Although no published data are available on the resistance and metal arc welding properties of 90-10, reports from the field indicate that this alloy yields good to excellent welds.

90-10 Cupro Nickel is being used in place of 70-30 Cupro Nickel in the manufacture of Duplex Tubing. The most popular combinations involve 3S aluminum, stainless steel and low carbon steel-lined or clad with 90-10 Cupro Nickel.

COMPARATIVE PHYSICAL AND MECHANICAL PROPERTIES OF CUPRO NICKEL ALLOYS

ANALYSIS	70-30 Nominal	70-30 Commercial Limits**	80-20 Nominal	80-20 Commercial Limits**	90-10 Nominal	90-10 Commercial Limits**
Copper	70%	66 min.	80%		90%	
Nickel	30%	29 min.–33 max.	20%	19 min.–22 max.	10%	9 min.–11 max.
Iron		0.6 max.		0.6 max.		50 min.–2.0 max.
Zinc		1.0 max.		1.0 max.		1.0 max.
Lead		0.05 max.		0.05 max.		0.05 max.
Manganese		1.0 max.		1.0 max.		1.0 max.
Tin		1.5 max.		1.0 max.		

MECHANICAL PROPERTIES	70-30 Soft	70-30 Hard	80-20 Soft	80-20 Hard	90-10 Soft	90-10 Hard
(a) Tensile Strength, 1,000 psi	55	80	49	80	45	60
(b) Yield Strength, 1,000 psi	22	70	14	75	15	55
(c) Elongation in 2 inches %	45%	5%	40%	3%	40%	5%
(d) Contraction in Area %	75%	*	*	*	*	*
Rockwell Hardness, F scale	*	*	F 71	F 107	F 65	*
(e) Rockwell Hardness, B scale	B 35	B 84	B 25	B 81	*	B 75
(f) Elastic Limit psi	14-18	64-69	11-17	64-78	*	*
(g) Modulus of Elasticity in Tension, psi	22,000,000		20,000,000		*	

PHYSICAL CONSTANTS			
Density at 68°F, lbs./cu. in.	0.322	0.323	0.323
Specific Gravity	8.94	8.94	8.94
Melting Point °F, Liquidus	2260°F (1240°C)	2190°F (1200°C)	2060°F (1145°C)
Solidus	2140°F (1170°C)	*	*

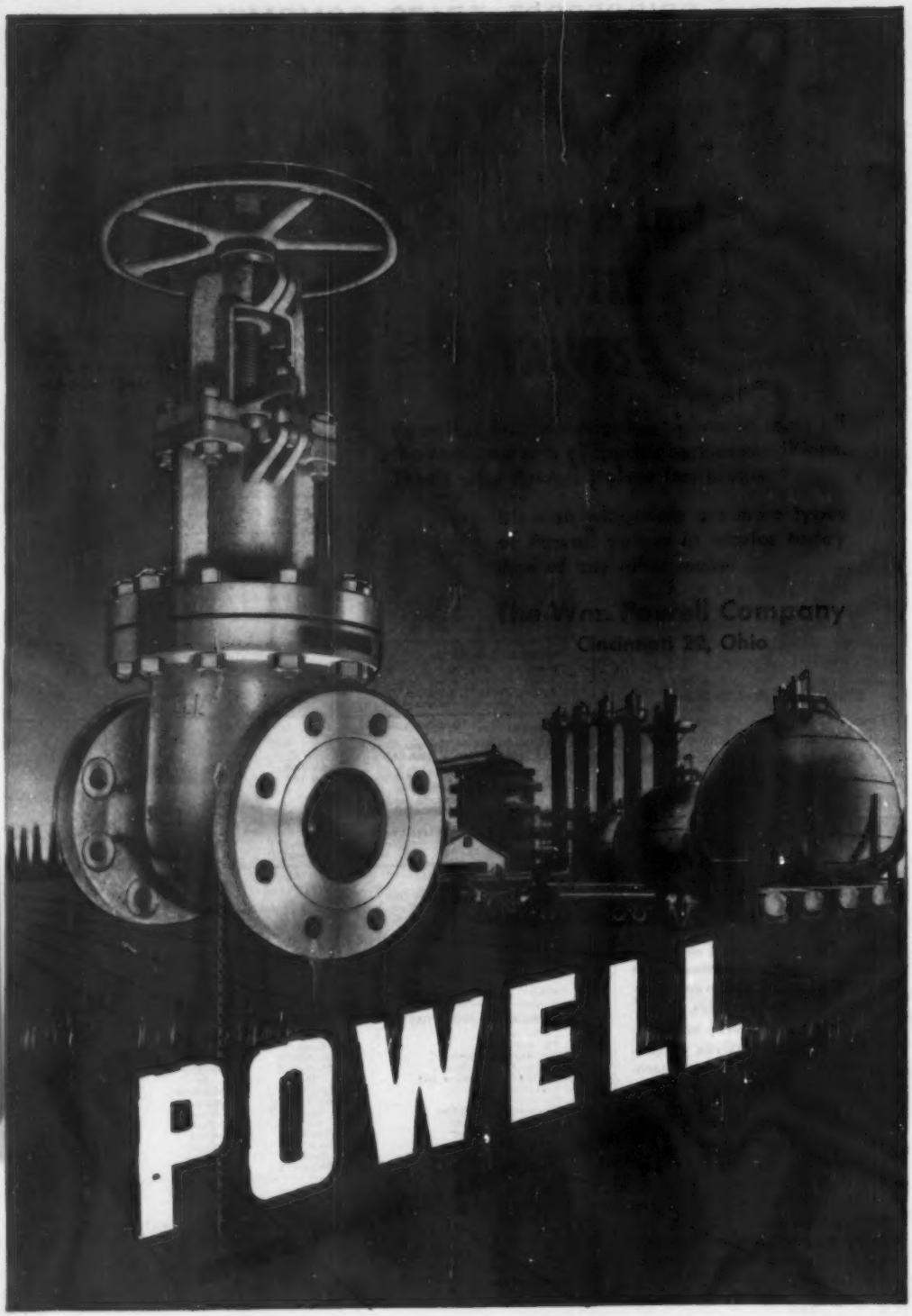
THERMAL			
(a) Coefficient of Thermal Expansion per °F from 68°F to 572°F	9.0 x 10^{-6}	9.1 x 10^{-6}	9.3 x 10^{-6}
per °C from 20° to 300°C	16.2 x 10^{-6}	16.4 x 10^{-6}	16.7 x 10^{-6}
(b) Thermal conductivity at 68°F Btu/sq. ft./ft./hr./°F	17	21	26
Calories/cm^2/cm/sec/°C @ 20°C	0.07	0.09	0.11
(c) Thermal capacity (spec. heat) @ 68°F	0.09 Btu./lb./°F	*	*
@ 20°C	0.09 cal./gm/°C	*	*

ELECTRICAL			
(a) Resistivity, ohms/mil foot @ 68°F (annealed)	225	160	115
(b) Conductivity, % I.A.C.S. @ 68°F (annealed)	4.6%	6.5%	9.3%
(annealed) megmho-cm^3 @ 20°C	0.027	0.038	0.055
(c) Resistivity, microhm centimeters @ 20°C (annealed)	27	27	19
Color	White Silver	Dull White Silver	Pink Silver

FABRICATION PROPERTIES			
Cold working	Good	Good	Good
Hot working	Good	Good	Good
Hot working Temp. °C	925-1050°C	900-1010°C	850- 960°C
Hot working Temp. °F	1700-1900°F	1650-1850°F	1550-1750°F
Machinability rating (d)	20	20	20
Soft soldering	Excellent	Excellent	Excellent
Silver soldering	Excellent	Excellent	Excellent
Oxyacetylene welding	Good	Good	*
Carbon arc welding	Fair	Poor	*
Resistance welding	Excellent	Good	*
Metal arc welding	Excellent	Good	*
Polishing	Good	Good	Good
Annealing temperature	1250-1600°F	1200-1600°F	1150-1600°F

SPECIFICATIONS—TUBE: 70-30	80-20	90-10
ASTM-B 111-50	ASTM-B 111-50	ASTM-B 111-50
MIL-T-15005 Amend. 4		MIL-T-15005 Amend. 4
U. S. Navy 44T 39a		
MIL-T-16420 (Ships) 1 July 1951 (Supersedes 44T 40a)		

*Data incomplete. **A.S.T.M. Specifications.


The Wm. Powell Company
Cincinnati 22, Ohio
POWELL

The MONTH...

barrels daily.

President Vargas in his message to the Brazilian Congress earlier this year said the final stage of the nationalization plan would be reached when Brazil ceased to consume any foreign oil and had domestic production to fill domestic demand. N.P.C. this year has completed two successful wildcats and in view of estimated increased production is considering the possibility of increasing the capacity of its Mataripe refinery at Bahia beyond the presently authorized expansion.

Gilmore Plans Building New West Coast Refinery

Plans to operate the much discussed Progress Pacific Pipe Line Company as a common carrier have been switched to operation on a contract or subsidiary basis. If it is to be a subsidiary, said Marc D. Leh, co-owner, it will affiliate with the Gilmore Refineries Company. Gilmore Refineries intends to build a 50,000 barrel-a-day refinery in West Texas to supply the Pacific Coast area.

Leh, who says he has already earmarked a gasoline market in California that will consume 72 million gallons per month, proposes to demonstrate the unlikelihood of trusts in the industry by his ease of entry into the market. As a common carrier, 80 percent of capacity would be controlled by major companies, Leh declared, and it is his intention to give relief to independents.

Esso Employe Joins NPA

Osgood V. Tracy, general manager of Esso Standard Company's Chemical Department, has taken leave of absence to

THE OIL MAN'S CALENDAR

NOV. 20	NGAA Regional, Amarillo, Herring Hotel.
22-23	Independent Petroleum Assoc. of America, Annual, Houston, Shamrock Hotel.
25-30	American Society Mechanical Engineers, Annual Meet, Atlantic City, Chalfonte-Haddon Hall.
26 to Dec. 1	Exposition of Chemical Industries, New York, Grand Central Palace.
DEC. 2- 5	American Institute Chemical Engineers, Atlantic City, Chalfonte-Haddon Hall.
26-31	American Assn. for the Advancement of Science, Annual, Philadelphia, The Bellvue-Stratford.
JAN., 1952	
14-17	Plant Maintenance Show, Philadelphia, Convention Hall.
14-18	Society of Automotive Engineers, Inc., Annual, Detroit, Hotel Book-Cadillac.
MAR. 3- 7	ASTM, Spring and Committee Meeting, Cleveland, Ohio, Hotel Statler.
8-10	Southwestern Gas Measurement Course, U. of Oklahoma, Norman.
10-14	Natl. Assn. of Corrosion Engineers, Annual Conference and Exhibition, Galveston, Galvez Hotel.
16-19	AIChE, Regional, Atlanta, Biltmore Hotel.
31- Apr. 1-2	WPRA, 40 Annual, San Antonio, The Plaza Hotel.
16-18	National Petroleum Association, Semi-Annual, Cleveland, Hotel Cleveland.
30 May 1- 2	Natural Gasoline Association of America, Annual, Houston, Rice Hotel.

Keep your eye on V·P·I
WHEN SELECTING
BLOWERS

CENTRIFUGAL

Type OI Centrifugal Blower in southwestern refinery. Capacity 13,000 cfm.

You can't afford to risk shutdowns today because of unsatisfactory or inadequate equipment performance. To keep production moving at the required fast pace, calls for blowers or gas pumps that continuously deliver positive Volume at required Pressure—and at low power costs to reduce operating expense.

You get these 3 essentials from R-C Blowers and Gas Pumps. Whether your needs call for Centrifugal or Rotary Positive units, we can match them from our exclusive *dual-ability line.* With capacities from 5 cfm to 100,000 cfm, you can usually find R-C units that closely fit your demands, with resultant savings in time, cost, space, weight and power.

From an experience of almost a century of blower building, our engineers will gladly make suggestions of the right R-C equipment to move or measure gas and air to keep production going.

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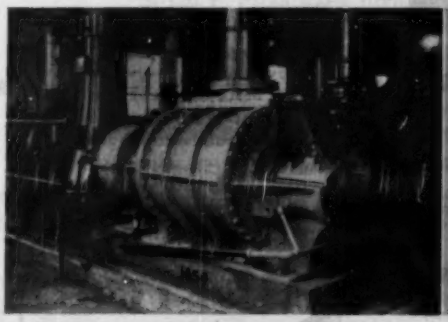

ROTARY

Rotary Positive Gas Pump for handling refinery gas. Capacity 3,100 cfm.

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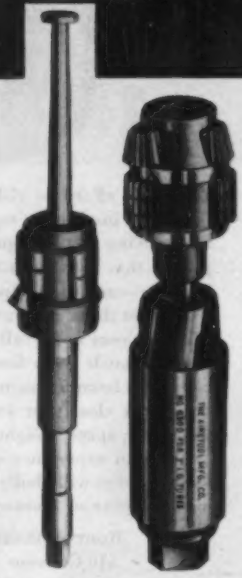
ONE OF THE DRESSER INDUSTRIES

AIRETOOL tube cleaners and expanders have long been the leaders in their respective fields. Maintenance crews prefer them because they are fast, easy to use and don't "conk out" just when they are needed most. In design, in performance, in results, you can't beat AIRETOOL refinery tools. They're TOPS.



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AIRETOOL's amazing Tube Rolling Control delivers a new high in accuracy and speed to every tough job when it comes to rolling heat exchanger and condenser tubes. A powerful motor drives an AIRETOOL ball-bearing type expander which is mechanically controlled to stop at the precise second when perfect expansion has been accomplished. Full details will be sent by return mail. Write The AIRETOOL Manufacturing Company, 316 S. Center St., Springfield, Ohio.

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AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

There's an AIRETOOL Tube Cleaner and Tube Expander for every Type of Tubular Construction

The MONTH...

join the National Production Authority as deputy director of the Chemical Division in charge of the program and statistics branch.

Geologists Elected Vice Presidents of Caltex Group

F. C. Sealey and E. M. Butterworth have been elected vice presidents of the

Sealey

Butterworth

California Texas Oil Company, Ltd.

Sealey began his association with the oil industry in 1917 as an assistant geologist with The Texas Company. For the past thirteen years he has been active in oil producing activities abroad, serving with the Caltex-Bahrein group as head of producing and exploration since 1949.

Butterworth, a geologist, graduated from the University of California in 1916. After 1924 he was active in the East Indies, guiding exploration in that area. Recently he has been concerned with government relations in Sumatra and New Guinea in behalf of the Caltex-Bahrein group.

California Texas Oil Company also has created a new executive staff position, vice president and director of marketing policy and coordination, and named A. J. Singleton, recently elected a director of the Company, to function in the new position and also as permanent chairman of the marketing coordination committee.

Snyder

(Continued from Page 166)

troleum gases. Adjoining the Snyder gasoline plant, Sunray operates three storage wells with a combined capacity of 3.7 million gallons. Besides the saving in tank steel, the underground storage facilities will serve to stabilize the LPG market, since it will not be necessary to flare surplus LPG during the summer months nor to sell these products at depressed prices during the mid-year season of low demand.

The building of the Snyder gasoline plant as a cooperative enterprise by the owners and producers in the area means that millions of barrels of rich gas, formerly flared as waste when the oil was produced directly to storage tanks, is now being channeled to usable purposes through oil-gas separators and processing which extracts the valuable liquids from the wet field gases.

The plant is serving an area embracing approximately 34,000 acres of productive leases in the Kelley-Snyder field, producing mainly from the prolific Canyon Reef, and is connected to some 860 producing oil wells in the group. It is estimated that these acres have recover-

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condenser tubes for

"CAT CRACKER"

with the **world's**

largest throughput

Here are five of the eight fractionator overhead condensers which will serve the fluid catalytic cracking unit with the world's largest throughput — the 60,000 BPD unit now being built by The M. W. Kellogg Company for the Gulf Oil Corporation's Port Arthur (Texas) refinery.

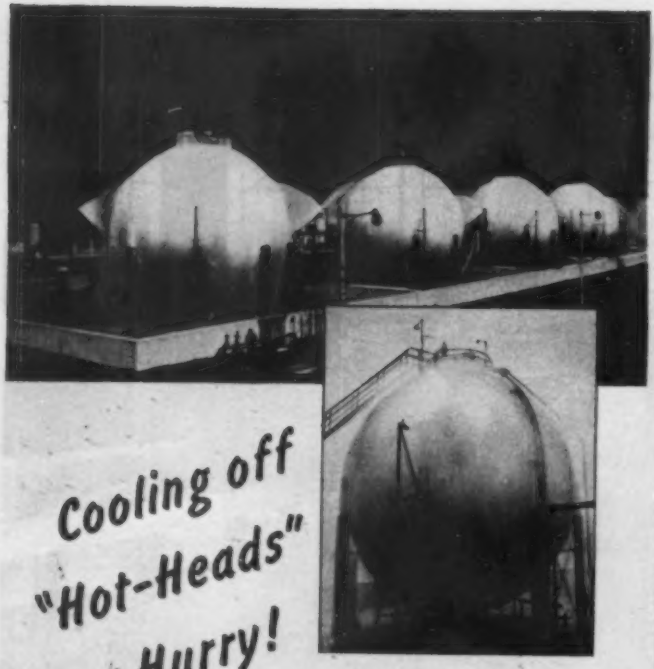
A mixture of steam, hydrocarbon vapors and inert gases will enter the condenser shells at 265°F. and exit at 120°F. Fresh water from a cooling tower will enter the tubes at 93°F. and 4 ft. per sec. velocity.

Severe corrosive or erosive action on either hydrocarbon or water side is not anticipated. ANACONDA Arsenical Admiralty Tubes conform to specifications requiring Admiralty, which is characterized by Kellogg's engineers as most economical for this job.

They say: *"Admiralty has proved over the years to be the best tube material for mild corrosive conditions . . . In the past 20 years a very substantial majority of all tubes used have been inhibited Admiralty."*

ANACONDA Arsenical Admiralty can be used with confidence in any application where inhibited Admiralty is desirable. For information about this or other condenser or heat exchanger tube materials and applications, write to The American Brass Co., Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

For efficient heat transfer ANACONDA® HEAT EXCHANGER TUBES



Cooling off "Hot-Heads" in a Hurry!

SHOULD normal temperatures rapidly rise to a dangerous point things happen fast around highly inflammable liquids—in fact, too fast for any fire protection system that doesn't go into immediate action! Blaw-Knox Sprinkler and Fog Nozzle Systems do just that. Actuated by rate-of-rise thermostats, they hit the hot spot with a quenching, cooling pattern of water that stops fire in its tracks. And do it with untreated water at normal pressures! Glad to give you a preliminary survey and estimate costs without obligation.

BLAW-KNOX SPRINKLER DIVISION
OF BLAW-KNOX CONSTRUCTION COMPANY
829 Beaver Ave., N.S., Pittsburgh 12, Pa.
Offices in Principal Cities

The MONTH...

able crude reserves of 300 million barrels if no repressuring methods are used. Petroleum engineers now working on recommendations for a Scurry repressuring project hope production can be approximately doubled by unitization and if pressure maintenance is instituted.

Gen. Thompson Gets API Service Medal

One of the highlights of the American Petroleum Institute's Thirty-first annual meeting in Chicago this month was the presentation of the Gold Medal for Distinguished Achievement to General Ernest O. Thompson, chairman of the Texas Railroad Commission.

General Thompson, who received the award at the general session on Thursday, is noted for his conservation work in the field of petroleum. Active militarily during both World Wars he was an active member of the Texas National Guard even prior to World War I. General Thompson was called to serve on the Railroad Commission in 1932. Since that time he has been instrumental in establishing legislation to provide for the conservation of petroleum resources in Texas.

Following a period of chaos in the East Texas field in 1932, General Thompson set up a proration method of control in Texas which provides for oil production in direct relation to market demand and transportation facilities.

Educated at Virginia Military Institute, Eastman Business College and the University of Texas, where he received an L. L. B. degree, he also has been awarded honorary law degrees from Texas Technological College and Texas Christian University.

Following World War I, General Thompson practiced law in Amarillo and served as mayor for two terms. Since 1932 he has been active in conservation of petroleum resources both as a member of the Texas Railroad Commission, and on a national scale. He attended the 1937 World Petroleum Congress in Paris as the personal representative of President Roosevelt and this past summer attended the Third World Petroleum Congress at the Hague as an official representative of the government.

OIIC Awards

Certificates of Appreciation were presented by the Oil Industry Information Committee to 29 oil men during the 31st annual meeting of the API in Chicago, in recognition of their outstanding work and contributions to the oil industry's public relations program. This is the first time that such certification has been given to men who helped establish and operate the program in various parts of the country.

Recipients of the certificates were: W. J. Arnold, The Pure Oil Company, Chicago; George A. Beattie, Wofford Oil Company, Atlanta; North Bigbee, formerly with Texas-Mid Continent Oil and Gas Association, Dallas; Joseph W. Butler, Butler Oil Company, Philadelphia; Jack Clarke, Texas Eastern Transmission Company, Shreveport; Robert E. Garrett, Gulf Oil Corporation, Philadelphia; William J. Gerwe, Socony-Vacuum Oil Company, Inc., Chicago;

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in CARBON, ALLOY and STAINLESS STEELS
. . . Still your best buy, because W-S longer service life and increased dependability give that permanency which will lower maintenance costs . . . They are drop forged.
Basic materials are selected from a wide choice of carbon, stainless and alloy steels and then subjected to the most exacting metallurgical controls from melt to bar. Through these precautions and subsequent precision machining operations, W-S assures the utmost in accuracy of finish, perfection of threads, sockets, angles and concentricity. All W-S Fittings, — Screwed and Socket Welding Types, — are finally instrument inspected.
W-S Bulletin A3-50 details the Carbon Steel Line. Bulletin S-1 is devoted to Stainless and the Alloys. W-S will gladly furnish information on the new FEATHERLITE Fittings — a recent big step in a wide range of services. Write today for the specific bulletin you desire.
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PLUGS ARE OUT WITH CHLORINATION

Costly plug cleaning, with its high labor bills and lengthy equipment down-time, goes out of the condenser and heat exchange picture the minute chlorination arrives.

This proven process for cutting the costly effects of back pressure and poor heat transfer characteristics caused by slime, really works, as one Southern Power Station found out when they began using the W&T De-sliming Process.

In just six months after W&T Chlorinators were installed, cleaning and excess steam costs were reduced from $1450 per month to $250 per month and a later survey showed an overall saving in excess steam costs of $16000 in a year.

Such savings are indicative of how your condensers may be made to operate more economically and with far less outage when W&T Engineers install chlorination to fight your slime problems.

To learn how chlorination may be profitably applied to your heat exchange equipment and to take advantage of W&T's 35 years' experience, write today.

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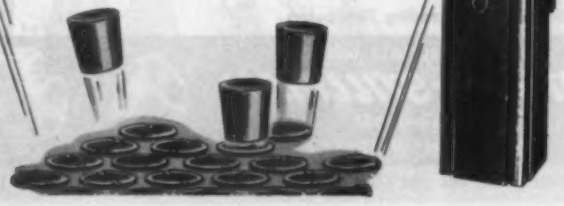


CD-31

The MONTH . . .

Charles J. Guzzo, Gulf Oil Corporation, New Orleans; Paul Hirth, Continental Oil Company, Denver; J. B. Hutchinson, Aetna Oil Company, Louisville; O. Y. Kirkpatrick, retired from The Pure Oil Company; Joseph A. Lentz, Continental Oil Company, Denver; Wiley L. Moore, United States Oil Company, Atlanta; Fred F. Murray, Oil Well Supply Company, Dallas; Charles R. Musgrave, Phillips Petroleum Company, Bartlesville; L. C. Pfaff, Socony-Vacuum Oil Company, Inc., St. Louis; R. F. Pielsticker, Skelly Oil Company, Tulsa; R. R. Potts, Socony-Vacuum Oil Company, Inc., Boston; O. W. Regestein, Socony-Vacuum Oil Company, Inc., New York; M. H. Robineau, Frontier Refining Company, Denver; B. F. Shea, Esso Standard Oil Company, Boston; E. Dale Smart, Skelly Oil Company, Omaha; Guy L. Tate, Magnolia Petroleum Company, Dallas; L. E. Ulrope, Esso Standard Oil Company, New York; Edgar A. Waite, formerly with Standard Oil Company of California, San Francisco; Eric V. Weber, Ohio Petroleum Marketers Association, Chevoit, Ohio; L. S. Wescoat, The Pure Oil Company, Chicago; John Wieland, The Standard Oil Company (Ohio), Cleveland; Willard W. Wright, Sun Oil Company, Philadelphia.

Safety Awards

The Safety Committee of the Board of Directors of the API presented Certificates of Appreciation to three men during the group session. The recipients were as follows:

Joseph C. Bernd, retired but formerly with Sinclair Refining Company at East Chicago, Ind., for 20 years of tireless service as chairman and member of accident-prevention committees, and especially for his notable contributions in the preparation of API accident-prevention manuals.

Roy S. Bonsib, retired but formerly with Standard Oil Company (N. J.) at New York, for seven years of conscientious service as chairman and member of accident-prevention committees.

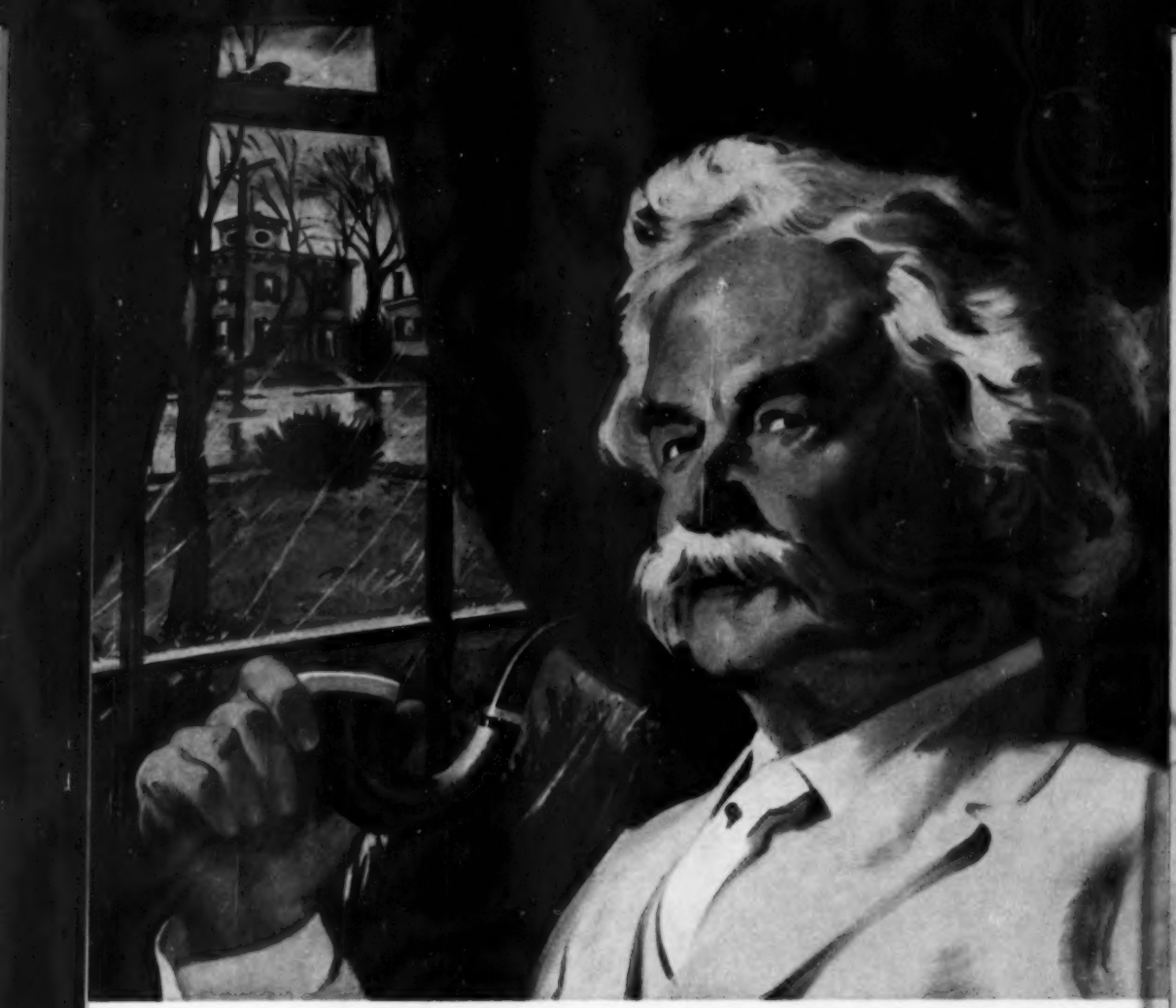
C. Elmer Townsend, retired but formerly with Sun Oil Company at Philadelphia, for sevrice as chairman and member of fire-protection committees, who for 22 years rendered outstanding service to the Institute, notably in the protection of the petroleum industry against unnecessarily restrictive fire-protection laws and regulations, and especially for his effective representation of the Institute on the Committee on Flammable Liquids of the National Fire Protection Asscciation.

Refining Division Elections

At the only meeting of the Division of Refining, elections were held to name 1952 members of the General committee for that division. The meeting, presided over by William Lyman Stewart, Jr., of the Union Oil Company of California, was addressed by Ralph Gwin Follis, Standard Oil Company of California, who spoke on the situation affecting Middle East oil.

Gulf Oil to Add Lube Oil Blending-Packaging Plant

New blending, drumming and canning plant facilities will be added by Gulf Oil Corporation at its Cincinnati plant to



You had something there, Mark Twain

We doubt if the beloved Mark Twain had gasoline refiners in mind when he was reported to have said:

"Everybody talks about the weather, but nobody does anything about it!"

But he certainly was hitting close to the problem which has for many years vexed refiners who wanted to obtain reliable road knock-ratings. There are hardly two days in a year when the same weather conditions are to be found . . . not to mention traffic variables. As a consequence, a day-to-day variation of four octane numbers was possible in the rating of a single fuel in a particular automobile. Fuel ratings obtained indoors on chassis dynamometers often were subject to considerable variation, and sometimes bore little relation to performance on the road. This is not surprising, because of differences in atmospheric temperature and humidity, and failure of the equipment in the chassis dynamometer room to provide "wind" equivalent to that encountered in normal car operation.

So Ethyl research people did something about it

They built two unusual chassis-dynamometer rooms in which atmospheric temperature and humidity can be closely controlled. Furthermore, air velocity against the front of the car

(*Continued on next page*)

You had something there, Mark Twain

(*Continued from preceding page*)

is automatically controlled relative to the speed of the rear tires. The two rooms constitute a flexible combination which can accommodate a wide range of automotive vehicles operated under substantially any combination of temperature, humidity and wind encountered in service.

A Real "Indoor Highway"

Simulation of vehicle operation on the road is further assured by equipment which causes the acceleration and speed of the rear wheels to be the same as those on the road resulting from any movement of the foot throttle.

Refiners who use Ethyl's all-weather rooms and accompanying fleet of modern cars in their research programs are now able to obtain . . . quickly and accurately . . . knockratings on current gasolines that duplicate what their customers would experience under actual road conditions. Long-range programs can be started with the assurance that the conditions of a test can be duplicated at any time in the future. Refiners whose gasoline is used under a variety of weather conditions can check its performance under any combination of conditions within the range likely to be encountered.

Other methods of evaluating fuel antiknock quality now used in the laboratory or on the road have value for control and demonstration purposes, and are employed in Ethyl's research and gasoline-testing laboratories. The advanced type of road knocktesting carried on in Ethyl's new all-weather rooms sets a new standard in the significant evaluation of gasoline antiknock quality . . . thus it becomes a most important service to refiners.

The next time you are in Detroit we shall be glad to show you these rooms. In the meanwhile, our descriptive brochure about them entitled "Road Knockratings Indoors with Ethyl's New All-Weather Rooms" is yours for the asking.

ETHYL CORPORATION

NEW YORK 17, N. Y.

Ethyl service is backed by 28 years of antiknock experience

RESEARCH

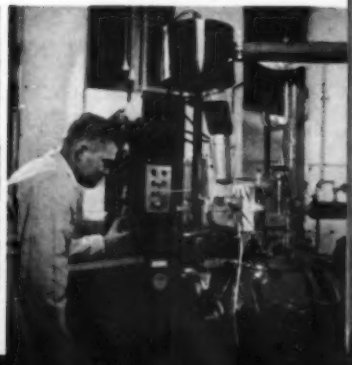
SALES HELPS

FARM SERVICE

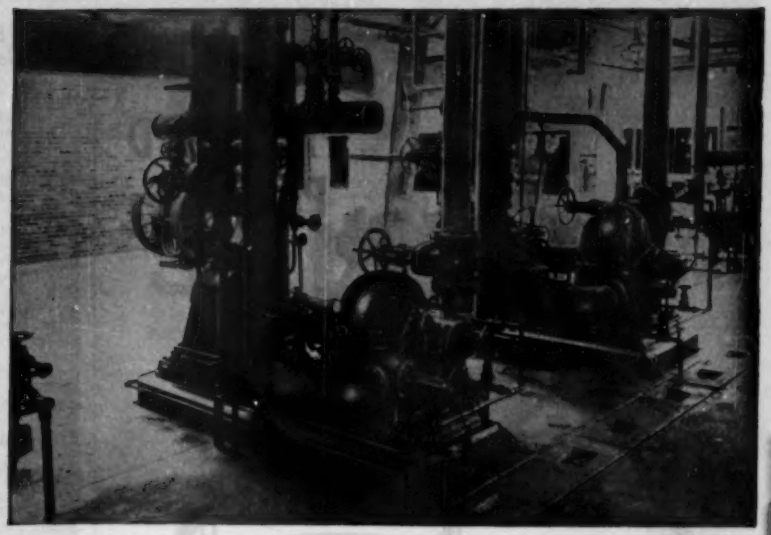
ROAD TESTING

SAFETY SERVICE

GASOLINE TESTING



TERRY



THE ROTORS OF THESE 75 H. P. TERRY TURBINES ARE DOUBLE RIM PROTECTED

The two 75 H.P. Terry Turbines shown above (in the plant of a leading refiner) employ the Terry Solid Wheel Rotor. The wheel is made from a single steel forging and the buckets are milled directly into the wheel. — All as shown in the illustration at the left.

The buckets are protected by rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the clearance became reduced.

With this construction it is impossible for the blades to foul and frequent inspections of the thrust bearing are not required to obtain safe and dependable operation.

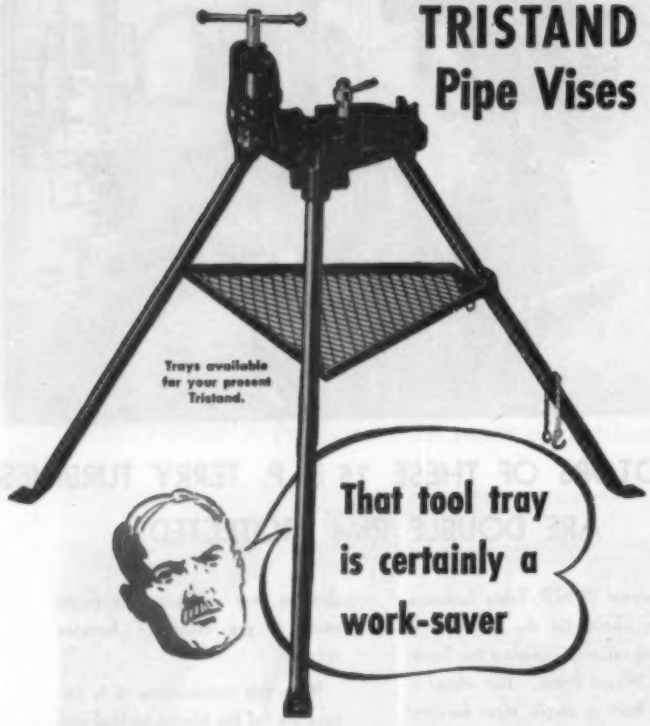
This feature and many others of the Terry Wheel Turbine are fully discussed in our Bulletin S-116.

T-1109

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Handy work bench is a Bonus!

WITH RIGID TRISTAND Pipe Vises



• It's right there when you need it—the handy workbench built into every Tristand. New tray keeps tools at your fingertips—less stooping, easier work. Tray makes Tristand rigid—won't fold up in use. Legs have rubber feet to prevent travel. LonGrip tool-steel jaws won't slip, won't mar polished pipe and tubing. Yoke vise, 2½" capacity; chain vise, 4". Buy these new work-saver RIGID Tristands at your Supply House.

RIGID

★ Work-Saver Pipe Tools ★

The MONTH . . .

cut midwestern delivery expense and improve service. The company's supply of lubricating oil and similar products for Ohio, Indiana, Illinois, Michigan and Kentucky have been packed at Port Arthur, Texas, or Philadelphia refineries, which has meant a long freight haul to distributors and dealers in the Mid-West.

Houdry Executive Given Professional Progress Award

Chalmer Gatlin Kirkbride, vice president and director of Houdry Process Corporation, has been chosen to receive the 1951 Professional Progress Award in Chemical Engineering sponsored by the Celanese Corporation of America. Administered by the American Institute of Chemical Engineers, the award carries a $1000 benefit, and is made each year to a technical engineer under 45 years of age in recognition of outstanding progress in chemical engineering.

Kirkbride

AIChE Annual Meeting Set

The annual meeting of the American Institute of Chemical Engineers will be held at Chalfonte-Haddon Hall, December 3-5, in Atlantic City. Highlights of the technical program will be symposia on industrial waste disposal and heat transfer, as well as individual papers from such diverse fields as coal gasification and atomic engineering.

Registration requests are being taken by J. L. Olsen, chairman of the registration subcommittee, Sun Oil Company, Marcus Hook, Pa.

DuPont Report on Research Octane Rating Holds Steady

Although research octane numbers for both premium and regular gasoline are slightly below April reports, the October publication of DuPont's Motor Gasoline Survey showed a slight recovery over July ratings.

The highest octane rating in October was 92.5 for premium in Baltimore; the low premium was 84.5 in Calgary, Alberta. For regular, the high was 86.1 in Philadelphia, and the low 77.2 in El Paso, Texas.

Between the July report and the October report, the octane ratings were increased for premium in 20 cities, increased for regular in 17 cities. Only four cities reported a decrease in premium, but 27 reported a decrease in regular gasoline.

Twenty-two cities increased the TEL content of premium grade gasoline; 16 showed increased TEL content of regular gasoline. A decreased content was reported by 26 cities for premium; 31 cities for regular.

Cit-Con Elects Simpson

F. M. Simpson has been elected president of Cit-Con Oil Corporation, succeeding Burl S. Watson. Watson has been appointed chairman of the execu-

5 Quality Products for the Petroleum Industry

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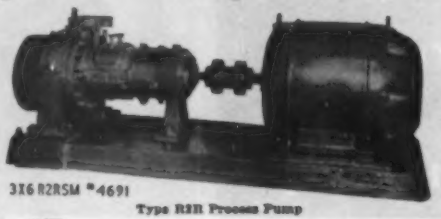
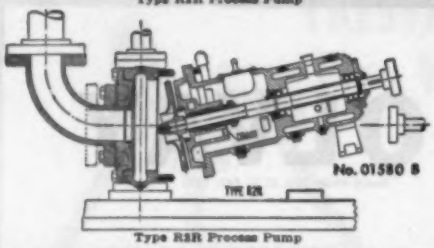
DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R. Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute.
Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

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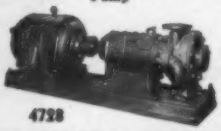
CENTRIFUGAL and RECIPROCATING PUMPS

Close Coupled Centrifugal Pump

Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

Pedestal Mounted Centrifugal Pump

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



Double Pedestal Bearing Centrifugal Pump

Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

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Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

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The MONTH . . .

tive committee. Simpson has served as vice president and general manager of the company since its organization in 1947.

Mitchell Elected AGA Chief Executive at Annual Meeting

George F. Mitchell, president of The Peoples Gas Light & Coke Company of Chicago, was elected president of the American Gas Association at its thirty-third annual convention in St. Louis last month.

Mitchell

Mitchell, a business college and Armour Scientific Academy graduate, entered the public utility field as a stenographer for the Commonwealth Edison Company, Chicago, in 1909. By 1913 he was secretary to the president of the company, and after successive promotions, became president in 1930. He is credited with introducing the therm rate on a major scale in this country.

Other officers elected included: Charles E. Bennett, president of The Manufacturers Light & Heat Company, Pittsburgh, first vice president; E. H. Eacker, president of Boston Consolidated Gas Company, Boston, second vice president; Edward F. Barrett, president of Long Island Lighting Company, Mineola, N. Y., treasurer.

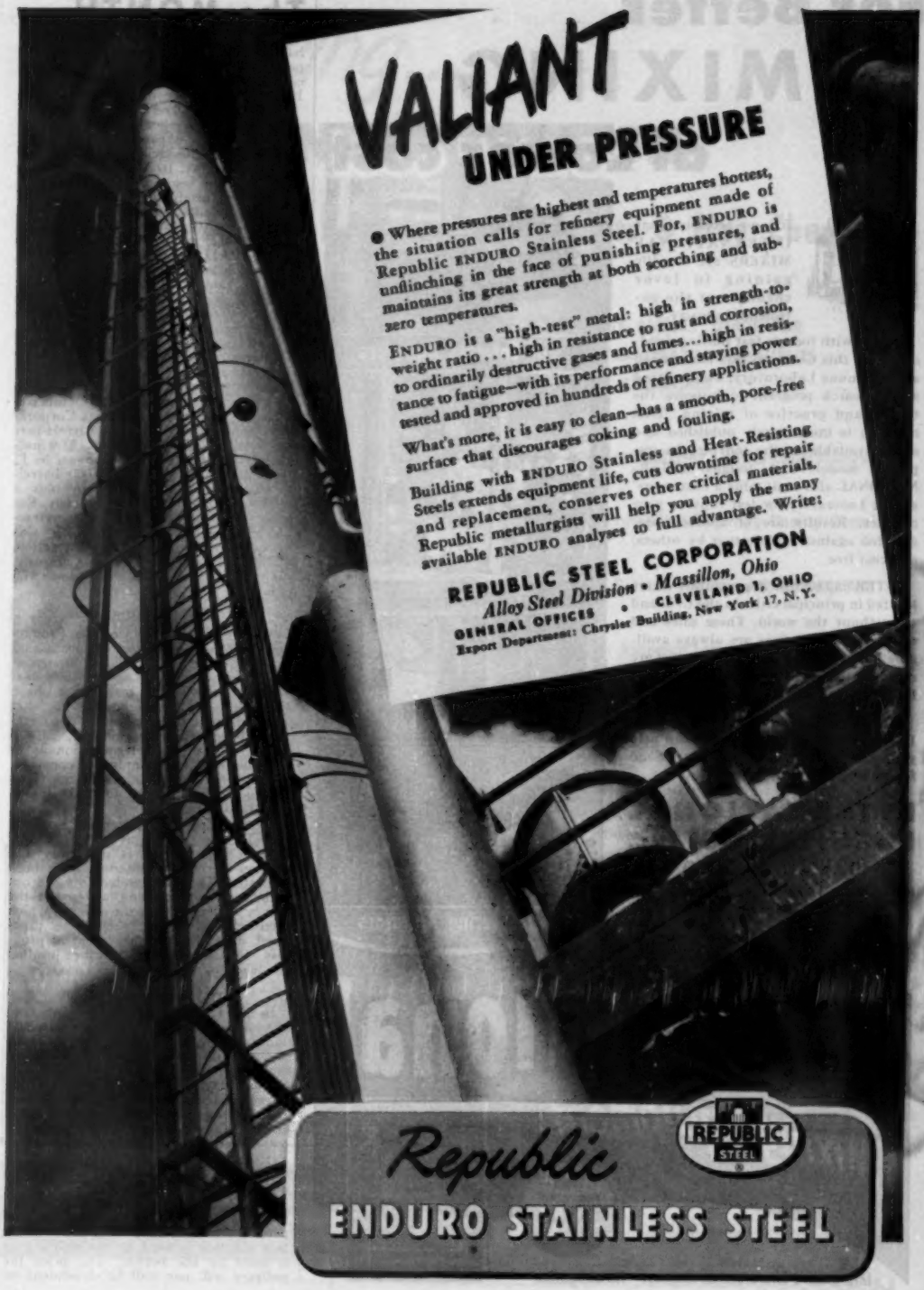
Oil Industry to Find Way To Meet Increasing Demand

"Convinced" that industry can meet all foreseeable defense mobilization needs and "fuel another war" if necessary, PAD spokesman A. P. Frame, said PAD "cannot agree with the gloomy predictions of any catastrophic oil shortage as forecast by some of the professional pessimists." Permitted its "fair share" of critical materials for use here and in friendly foreign countries, the oil industry will find a way to meet all military and essential civilian needs, Frame judged.

During the period from June 13 to September 25, PAD received applications for approval of construction projects in petroleum and gas industries totaling approximately $3.2 billion. Broken down in part the construction falls into: Gas projects, $1.3 billion; refining facilities, $845 million; oil pipe lines and storage, $672 million; natural gasoline plants and allied facilities, $182 million. PAD has approved projects totaling $2.1 billion of this total.

Among the refining projects approved for rapid tax amortization were the following: Sunray Oil Corporation, Corpus Christi, Texas, basic refining and alkylation units, $16 million. Frontier Oil Refining Corporation, Erie County, N. Y., basic refining and alkylation units, $5.4 million. Aurora Gasoline Company, Detroit, basic refining unit, $400,000.

Since September 30, 95 refinery projects approved by PAD call for the following expansion: crude runs, 77,495


VALIANT
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● Where pressures are highest and temperatures hottest, the situation calls for refinery equipment made of Republic ENDURO Stainless Steel. For, ENDURO is unflinching in the face of punishing pressures, and maintains its great strength at both scorching and sub-zero temperatures.
ENDURO is a "high-test" metal: high in strength-to-weight ratio . . . high in resistance to rust and corrosion, to ordinarily destructive gases and fumes...high in resistance to fatigue—with its performance and staying power tested and approved in hundreds of refinery applications.
What's more, it is easy to clean—has a smooth, pore-free surface that discourages coking and fouling.
Building with ENDURO Stainless and Heat-Resisting Steels extends equipment life, cuts downtime for repair and replacement, conserves other critical materials. Republic metallurgists will help you apply the many available ENDURO analyses to full advantage. Write:
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The MONTH . . .

barrels per day; alkylates, 26,210 barrels per day; catalytic cracking, 454,100 barrels per day; and catalytic reforming, 105,105 barrels per day.

PAD has approved more than 200 natural gasoline applications for facility construction or expansion, which at a cost of $90 million, will add about 86,000 barrels per day to light hydrocarbon output. At the beginning of World War II, national production of light hydrocarbons totaled about 221,000 barrels per day, making the new total an impressive increase, according to Richard P. Walsh, PAD director of Natural Gas Production and Processing Division.

Walsh said the LP-gas industry has grown 25 percent per year for the past several years, although now it is confronted with two particularly pressing problems, transportation and storage. Within the past six months, Walsh said, PAD has approved several LPG underground storage projects.

Fast tax write-offs as of October 5 included: Shamrock Oil & Gas Corporation, Sunray, Texas, 1600 barrels-per-day aviation alkylate project, $1.9 million. Esso Standard Oil, Bayonne, N. J., crude distillation unit of 20,000 barrel-per-day capacity, $1.5 million plus a $60,000 jet fuel terminal. Sinclair Refining, Marcus Hook, Pa., sulfur extraction, $320,000. Shamrock Oil & Gas Company, Sunray, sulfur extraction, $195,500. Phillips Chemical Company, Funica, N. M., sulfur extraction, $1.5 million.

New DPA Ruling

On October 19, the Defense Production Administration resumed processing of applications for rapid tax amortization following a 60 day moratorium during which only special projects had been considered. New rulings provide that approvals will be granted on construction started after November 1, only if DPA has made a determination as to shortage prior to beginning of construction. Priority will be given to ten types of projects in which sulfur ranks fourth and avgas ninth.

Relative to all applications now on file, DPA intends to ask all applicants whether construction is underway and whether necessary materials have been requested. This is intended to weed out abandoned projects and will assist the agency in determining the order in which pending applications should be processed, depending on the extent of progress and the nature of the product involved.

Army Alkylate Program

In mid October the military command offered the terms under which it would underwrite the rehabilitation or construction of alkylate facilities to boost the total national output by 31,000 barrels per day. Preliminary proposals will be submitted to PAD and if projects appear "adaptable to meeting the needs of expansion program," formal proposals will be requested by the Armed Services Petroleum Purchasing Agency. Congress has appropriated $82 million to make this program possible.

The refiner must agree to maintain facilities in working order for a five year period, whether the production of aviation alkylate is used by the military or is used by the refiner. The price the military will pay will be dependent on

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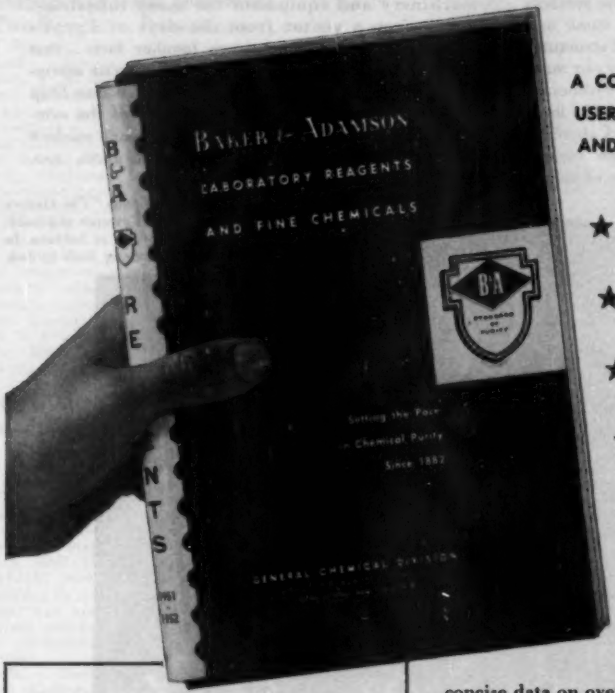

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30-11

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The workman of ancient Egypt knew the symbols of his trade. They helped him fashion stone and metal, wood and cloth, into the goods and structures which best served his era. . . . The needs of our modern industrial civilization are different. Visitors to Sun Ship's mighty shops see in the making the intricate steel fabric of petroleum refineries and chemical plants . . . massive bubble towers, pressure vessels, condensers, cracking cases, and a vast array of special machinery and equipment for many industries.

But even a visitor from the days of Egypt's Pharaohs would recognize two familiar facts—that strange modern "hieroglyphics" guide precise assembly of today's steel behemoths . . . and that Sun Ship workers are masters in their knowledge of the symbols and crafts of their trades. . . . The many modern industries served by Sun know these facts, too.

Illustration at top, reproduced from "The History of All Nations," shows ancient Egyptian shipbuilding as depicted on the tomb of Ti, at Sakkara. In contrast is the 55' regenerator being built by Sun.

Sun

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negotiations, and procurement by the Armed Services will be on a semiannual or annual basis.

William R. Boyd, III, has been appointed director of PAD's newly-established Facility Division. He has been a consultant for some time with the Munitions Board and PAD on the protection of petroleum facilities. He has been connected with Petroleum Advisers, Inc., N. Y., since World War II.

Standard Indiana Announces Two Directors, Promotions

Standard Oil Company (Indiana) recently announced the promotions of five men. S. A. Montgomery, assistant general manager of the manufacturing department, and A. C. Sailstad, formerly president of the Stanolind Oil Purchasing Company, were elected to the board of directors of the Standard Oil Company (Indiana). Sailstad has also been appointed general manager of the sales department. Montgomery continues in his present position as a manufacturing executive.

J. W. Ross, assistant general manager of consumer sales, was advanced to general sales manager. J. M. Hamer, assistant general manager for the western division, will succeed Ross, while A. V. Fraser, manager of the Minneapolis, Minn., sales field, will succeed Hamer.

ASME Annual Scheduled This Month at Atlantic City

This year's annual meeting of the American Society of Mechanical Engineers will be held in Atlantic City, November 26-30. The program will include over 220 technical papers and more than 90 sessions. Headquarters for the convention is in the Chalfonte-Haddon Hall Hotel. Membership of the ASME, now over 30,000, has been swelled by college graduates during the past five years and the meetings will stress guidance and inspiration by men of attainment directed toward this group.

W. C. Mullendore, president of Southern California Edison Company, Los Angeles, will deliver the Roy V. Wright Lecture this year.

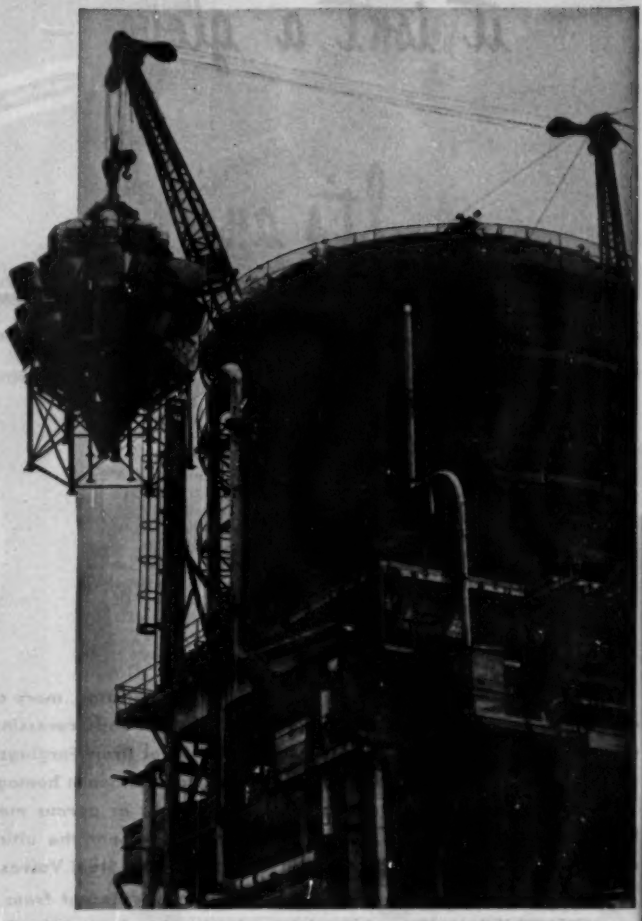
Trans-Empire Oils Purchases Operating Canadian Refinery

Moose Jaw Oil Refineries, Ltd., has sold its refinery at Moose Jaw, Saskatchewan, to Trans-Empire Oils, Ltd. Trans-Empire took over operation of the 300 barrel refinery recently. The refinery, with a crude run capacity of 1300 barrels daily, has been supplying diesel oil to the railways, bunker fuel to National Light & Power Company of Moose Jaw, and light-end products to the British American Oil Company.

Gulf Appoints Five Men to Development and Engineering

Dr. A. Lewis, Jr., has been appointed chief product engineer of the Product Development Department of the Gulf Oil Corporation. A native of Danville, Pa., he received his B.S. degree in chemistry from Ursinus College in 1938, and joined Gulf that year as an organic

BUELL IS TOPS
in catalyst recovery



In fluid or thermofor catalytic cracking Buell recovery systems have demonstrated continuous high-efficiency performance in all the major refineries. Design information is available on the latest multi-stage collectors. Buell Engineering Company, 70 Pine Street, Dept. 21-K, New York 5, N. Y.

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(Forged Steel)

The Orbit Forged Steel Valve is a smoother operating, more compact and easier handled tool built for today's production and processing operations. All principal parts are constructed of Steel Drop Forgings. These forgings, due to the hot working of the steel, form a dense homogeneous structure that better resists wear. No flaws, cracks or porous metal will be found—consequently, Steel drop forgings represent the ultimate in material for pressure equipment such as Orbit Forged Steel Valves.

The operation of the Orbit Valve is entirely different from that of conventional Valves. It provides globe valve seating, in that the Core Face moves directly into the Body Seat to effect a positive shut-off; Plug Valve turning, because the Orbit Core rotates a quarter turn in the Valve Body; and Gate Valve wedging, as tapered wedges are formed on the Orbit Stem, which wedge the Core into or away from the Valve Seat. Orbit Forged Steel Valves are *full round* openings.

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chemist. Continuing his work with Gulf, he received his M.S. degree from the University of Pennsylvania in 1940, and his Ph.D. from the University of Pittsburgh.

Returning to Gulf after a four year tour with the Navy, he was appointed to the Gulf Petroleum Fellowship at Mellon Institute, and has continued in that capacity until his present appointment.

Other promotional changes concern Robert L. Grun, H. H. Donaldson, R. P. Gilmartin and R. L. Nix. Grun has been appointed chief product engineer of the Industrial Lubricants and Specialties Section, on transfer from Industrial Products Engineering where he served as chief fuels and lubricants engineer.

Donaldson has been transferred from the Equipment Section to chief fuels and lubricants engineer, Marine Engine Section. He was in charge of Engine Testing of Lubricating Oil for Gulf Research & Development Company.

Gilmartin has been appointed chief fuels and lubricants engineer, Equipment Section to succeed Donaldson. Nix has been appointed chief fuels and lubricants engineer, Process Oil Section, succeeding Grun. He formerly worked in the Chemistry Division of the Research and Development Company.

All of the above men will be located in the Gulf Building, Pittsburgh.

Gilbert Named President of Panhandle Refining Firm

Roger Gilbert has been named chief executive officer of Panhandle Producing & Refining Company, effective January, 1952. A member of the Atlas Corporation since 1931, he was elected a vice president in 1939. He has been a director and chairman of the executive committee of Panhandle Producing & Refining Company since 1947. In addition he has represented Atlas on the directorates of Highway Trailer Company of Edgerton, Wisc., and on Argus Corporation, Ltd. of Toronto.

Gilbert

John V. Boyce resigned recently as president of Panhandle Producing & Refining.

SOD Adds New Personnel At Emeryville, California

Several Shell Development personnel announcements were made recently at the company's Emeryville, Calif., headquarters.

Ernest G. Holzmann, a graduate of University College of Nottingham, England, comes to Shell from Massachusetts Institute of Technology, where he was a research assistant in acoustics. He recently received the M.S. degree for his thesis on "Optimum Response in Relay Servomechanisms."

William B. Humble, who has been active in power engineering and consultant work in the San Francisco area, joined the staff of Shell Development as electrical engineer. Humble holds an

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37 Falling Accidents Every Hour*
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ROLLED STEEL FLOOR PLATE
This revolutionary ABRASIVE Floor Plate makes it possible for you to give your workmen the best non-slip protection against costly falling accidents.
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Architects, engineers, designers and safety engineers are specifying A. W. ALGRIP for industrial and commercial applications. Get complete information about this revolutionary ABRASIVE Floor Plate now. Write for booklet B-18
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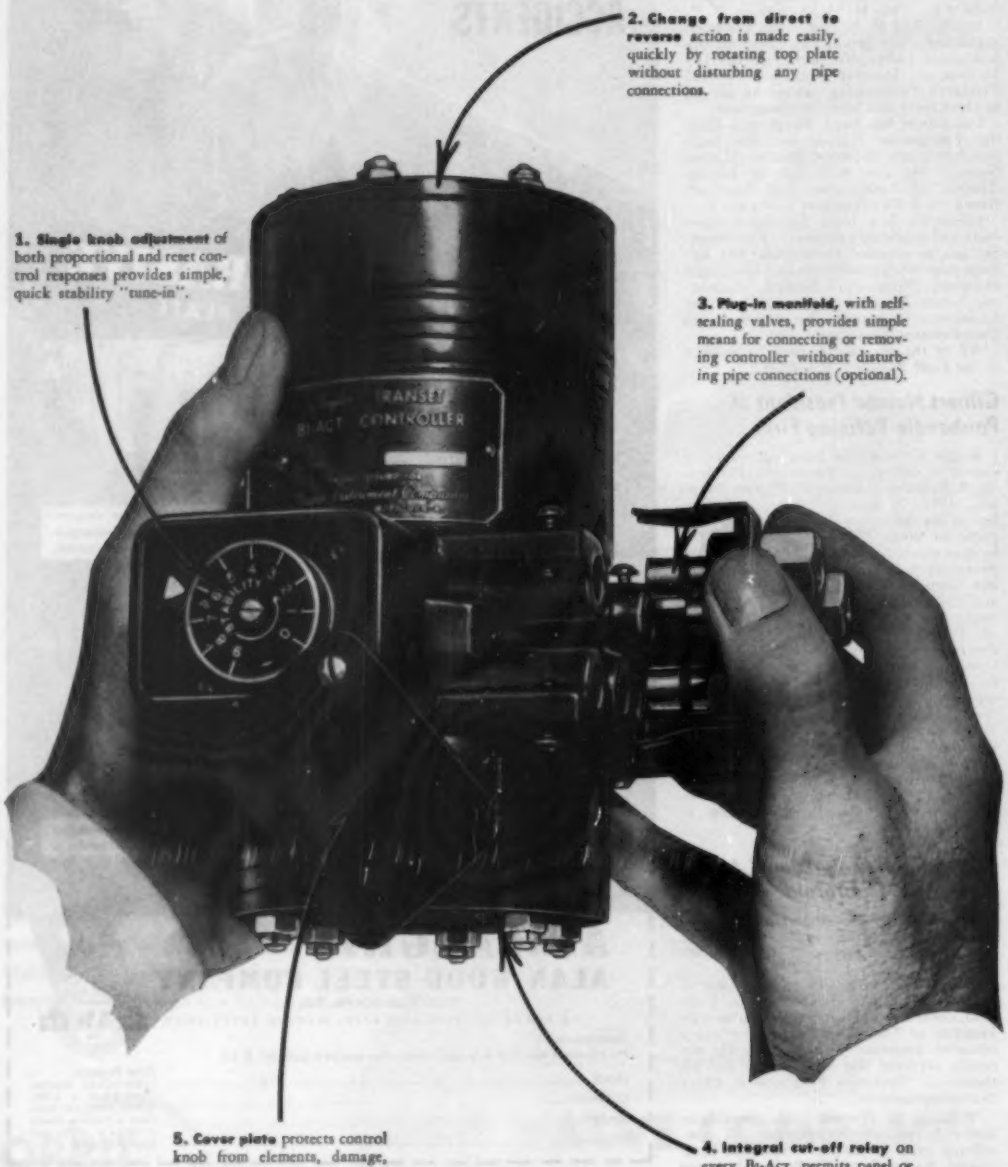
Other Products: PERMACLAD Stainless Clad Steel • A.W. SUPER-DIAMOND Floor Plate • Plates • Sheets • Strip • Alloy and Special Grades
*17% of the 222 occupational injuries which occur every hour are due to falls. Source: National Safety Council's 1949 edition of Accident Facts.

Here's Taylor's



2. Change from direct to reverse action is made easily, quickly by rotating top plate without disturbing any pipe connections.

1. Single knob adjustment of both proportional and reset control responses provides simple, quick stability "tune-in".

3. Plug-in manifold, with self-sealing valves, provides simple means for connecting or removing controller without disturbing pipe connections (optional).

5. Cover plate protects control knob from elements, damage, and tampering.

4. Integral cut-off relay on every Bi-Act, permits panel or field mounting.

New BI-ACT* CONTROLLER

Gives you single knob adjustment of both proportional and reset!

Here's a new, inexpensive force-balance controller incorporating a new control circuit. *One* stability knob adjusts *both* proportional and automatic reset responses. It's adaptable to practically any process . . . flow, pressure, liquid level and temperature . . . and particularly suited to applications requiring fast reset rates and broad proportional bands.

The BI-ACT CONTROLLER can be panel or field mounted. It can be changed from direct to reverse action and, with optional manifold, removed entirely without disturbing piping connections. SPECIFICATIONS: Gain 100 to .5 (Throttling range 1% to 200%) Automatic reset .1 to 120 repeats per minute. Size 7½" overall length. Standard operating range 3 to 15 psi. High capacity air valve.

This new BI-ACT CONTROLLER is the latest addition to Taylor's famous TRANSET* CONTROL SYSTEM, the new concept in pneumatic transmission control that is the talk of industry. Three component units, TRANSAIRE* TRANSMITTERS, TRI-ACT* or BI-ACT* CONTROLLERS and TRANSET* RECORDERS or INDICATORS, work together as a team to take full advantage of each others' superior performance in controlling practically any process variable.

For full details ask your Taylor Field Engineer, or write for Bulletin 98070. Taylor Instrument Companies, Rochester 1, N. Y., and Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

Taylor's Centennial — ACCURACY FIRST SINCE 1851

*Trade-Mark

Taylor Instruments MEAN ACCURACY FIRST IN HOME AND INDUSTRY

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85% MAGNESIA HEAT INSULATION

PABCO PRECISION MOLDED INSULATIONS

APPROVED ENGINEERING SERVICE UNIT

Modern engineering demands precise standards of heat insulation performance. Pabco *Precision Molded* 85% Magnesia combines the time-tested superiority of Magnesia with precision molding to give you a light weight insulation manufactured to very close tolerances.

Simpler and easier, to apply! Easier to lift, cut and score. Simpler to imbed tie wires flush in the surface, too!

LIGHT WEIGHT

Pabco *Precision Molded* 85% Magnesia weighs just 11 lbs. per cubic foot. In addition to its light weight, it also brings many timely advantages, including easy application and greater rind strength.

CLOSE TOLERANCES

Pabco's plus tolerance is only *½ lb. per cubic foot!* This means an amazing degree of control over such factors as Weight and Thermal conductivity. Other controlled factors include size, thickness and uniform fibre distribution.

Precision pipe fit! Both pipe coverings and blocks are molded to exact final size and thickness, not molded oversize and then "milled" to size.

THE DEPENDABLE STANDARD — "MODERNIZED"

quality

PABCO PRODUCTS INC.

INSULATION DIVISION

San Francisco 19 New York 16

Manufacturers of Heat Insulation Since 1920

PABCO ENGINEERING SERVICE UNITS IN ALL PRINCIPAL CITIES

The MONTH . . .

E.E. degree from the University of British Columbia.

Miss Mary Neal, a graduate of Northwestern University, has joined the company's staff as analytical chemist. Miss Neal was on the staff of Northwestern as research assistant in biochemistry before coming to Shell.

Other personnel additions to the Shell Development staff at Emeryville include: chemical engineers Lloyd F. Freechtle, who earned his M.S. at University of California this June; Richard W. Kunstman, University of Illinois, Ph.D. candidate; and Harry A. Wistrich, Jr., recent Ph.D. from Cornell.

B-A Board Elects Beringer, Murdoch as Board Chairmen

Milton S. Beringer has been elected chairman of the board of The British American Oil Company Ltd. of Toronto. Beringer, who joined British American 18 years ago, has been vice president of manufacturing for the past six years, and was appointed a director in 1950. He is also vice president and director of B-A-Shawinigan Ltd.

In addition, James Y. Murdoch was elected chairman of the executive committee of the board. Murdoch has served as director of B-A for 18 years, and is president of several large companies including Noranda Mines Ltd.

Elk Refining Company Elects New Executive Panel, Board

Elk Refining Company recently named Fred G. Bannerot, Jr., president and treasurer of the company. Ralph D. Lowe will continue as vice president of sales, and J. A. Bornmann as secretary. W. S. Zehrung of Oil City, Pa., was elected a vice president. Directors elected were Bannerot, Lowe, Bornmann, Zehrung, G. J. Hanks of Bradford, Pa., and G. A. Reid of Parkersburg, W. Va.

Banker Elected to Atlantic Refining Board of Directors

Harry C. Carr, chairman of the board of the First National Bank of Philadelphia, has been elected to the board of directors of The Atlantic Refining Company. Carr fills the vacancy on the board occasioned by the retirement of E. H. Blum, former vice president in charge of crude oil production.

Standard-Indiana Promotes Miller to Group Leader

Irving E. Miller, chemical engineer in the Standard Oil Company (Indiana) research laboratory at Sugar Creek, Mo., has been promoted to group leader.

Miller, who joined Standard in 1944, is a graduate of Kansas University.

ERRATUM

"Mutual Solubilities of Light Hydrocarbon-Water Systems", appearing in the October issue of PETROLEUM REFINER, quoted the higher isotherm of the butane-water solubility investigation as 200° F. instead of 220° F. This source error appears in the body of the article on pages 118 and 119 and in Figures 1 and 2.

Let's go...let's get that SCRAP in!

All your SCRAP is urgently needed, NOW

THE scrap shortage is serious. *Your* scrap—every pound of iron and steel scrap you can locate in your plant or factory—is vitally needed and needed right away. For unless you do everything possible to get this scrap on its way to the mills, steel production is bound to slow up. That can't be allowed to happen. But without your help it surely will.

It takes at least one-half ton of scrap to make one ton of steel. With the mills turning out more than 2 million tons of steel per week, over 1400 carloads of industrial scrap are needed *every day*. And industry, somehow, must provide it.

What you can do to meet this emergency

First, organize a permanent Scrap Salvage Committee and make the "drive-for-scrap" part of your daily operations. Search out every possible source of scrap. Turn your old and worn-out equipment, tools and machinery over to your scrap dealer, at once. Dig out your discarded dies, rusted-out tanks and boilers, your old rails and other miscellaneous junk, and start them back to the mills through your scrap dealer. Encourage every employee to report every retired or obsolete machine that now stands idle—see that it is turned in for scrap.

By getting this "dormant" scrap off your premises and into the furnaces you'll be helping not only yourself but America as well. *More* scrap turned in, means *more* steel turned out—it's as simple as that. So let's get going.

You'll find your local scrap dealers listed in the yellow pages of the phone directory.

USS

1-1328

This page would ordinarily be used to tell you about

NATIONAL SEAMLESS PIPE AND TUBES

but, because without SCRAP we cannot produce steel, we are asking instead for your all-out help in getting more SCRAP to the mills.

NATIONAL TUBE COMPANY, PITTSBURGH, PA.
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COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

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New Catalogs AND EQUIPMENT LITERATURE

For copies of the catalogs and new equipment literature listed, use one of the convenient Reader Service Postcards on this page. Just circle the number on the card corresponding to the number of the item in which you are interested.

Electrodes and Defense

Alloy Rods Company's new brochure entitled "Alloy Welding Electrodes for Defense Production" reviews the electrodes used during World War II and the experience gained from their use. It discusses new electrodes which have become available since that period. The history, properties and uses of a number of alloys are included in this compact booklet.

Circle No. 1 on Postcard

Packings

The complete line of Raybestos-Manhattan, Inc., Asbestos Fabric Packings is described in this new bulletin. It contains service recommendations, sizes, standard packages, and packaging specifications for High Pressure Rubber Back, Rubber Core and Dual Edge Packings.

Circle No. 2 on Postcard

Metering Pumps

Stainless Steel Maisch Metering Pumps are described and illustrated in special information sheets published by Mechanical Products Corporation, engineers, manufacturers and distributors. The Maisch pump is suggested for use in metering small volumes of solutions in a laboratory, or dispensing controlled volumes of liquids in processing operations.

Circle No. 3 on Postcard

Contact Controllers

Minneapolis-Honeywell Regulator Company's Catalog 8000 illustrates vane type electric contact control units used with Electr-O-Vane thermometers and pressure gauges, and with the ElectroniK Potentiometer. Also described are those used in the Pyr-O-Vane and Protect-O-Vane millivoltmeters to give snap-action on-off control.

Circle No. 4 on Postcard

Tantalum Data

Fansteel Metallurgical Corporation's new booklet, "Fansteel Acid-Proof Tantalum Equipment for Chemical Operations" contains information on the chemical and physical properties of tantalum, and detailed engineering descriptions of single and multiple tube bayonet heaters, coils, heat exchangers, etc.

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Name (Please Print)_____

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New Catalogs AND EQUIPMENT LITERATURE

Use one of the free and convenient Reader Service Postcards on this page to request copies of the catalogs in which you are interested.

Automatic Aircheck Valve

Bulletin 509 by Pennsylvania Pump and Compressor Company lists four advantages for installation of the PPC Aircheck valve on the discharge line of every air and gas compressor; dispenses with customary arrangement of stop, safety, globe valves; prevents leakage of pressure through compressor during "off" cycle; dampens pipe line pulsations; permits repairs without shutting down the system where more than one compressor is on the line.

Circle No. 6 on Postcard

Steam Plant Equipment

Steam plant equipment included in the Yarnall-Waring Company line is described in Yarway Bulletin WG-1911. Important improvements in Flat-glass inserts used in high-pressure gages, the improved visibility of meniscus, etc. are described. The pages are punched for notebook enclosure.

Circle No. 7 on Postcard

Recorders and Controllers

pH and Conductivity Recorders and Controllers manufactured by Minneapolis-Honeywell are described in their catalog 15-16. It includes new information on latest designs of pH electrodes and conductivity cells. Also included are fundamental operating principles, descriptions of measuring systems, and details of components, as well as typical applications.

Circle No. 8 on Postcard

Gas Analyzer

Instrumentation Data Sheet 10.15-4a, published by Minneapolis-Honeywell Regulator Company, contains information on a thermocouple type analyzer which uses Brown ElectroniK potentiometers for combustible gas analysis.

Circle No. 9 on Postcard

Wax Moulding

An illustrated booklet by the J. W. Greer Company, the "Greer Automatic Wax Moulding Machine," gives factual information on a machine for processing liquid wax into finished slabs.

Circle No. 10 on Postcard

Abrasives

"Grinding Know-How" published by the Norton Company, contains abrasive samples and lists the names of 16 informative booklets, including condensation of contents.

Circle No. 11 on Postcard

Bonded Elements

Ruge-de Forest Inc., has added two new RdF Stikon resistance thermometer elements, designated as Types BN-3 and BN-4, to the standard line. Included in the newly issued Bulletin T-1B, is information concerning the fast response provided to the temperature of the surface to which they are bonded. Stikon elements are suited for continuous service from —100° F. to 300° F.

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(More Literature Items on Pages 193, 195, 197, 199)

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A10	B10	C10	D10	E10	F10	G10	H10	J10	K10	L10	M10	N10	P10	Q10	R10	S10	T10	U10	V10

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Information on
NEW EQUIPMENT
ADVERTISED PRODUCTS

NEW EQUIPMENT and Manufacturers' Literature

KEEP INFORMED by requesting additional information on new equipment and services described here. SAVE TIME by using the Reader Service Postcards on opposite page. Circle number on card corresponding to the number listed at the end of each new equipment item on which you desire additional information.

Compression Pipe Coupling

A new style compression pipe coupling which is said to almost eliminate turbulence at the joint, is being manufactured by the Morris Coupling and Clamp Company. The coupling is made in sizes from ⅛ to 14 inches standard pipe sizes, and will couple ferrous to ferrous or non-ferrous materials. The Technical Bulletin describes uses, parts, and specifications.

Circle No. 13 on Postcard

Nickel Bulletin

"Engineering Properties & Applications of NI-RESIST" is a bulletin by the International Nickel Company, Inc., describing eight types of austenitic nickel alloy cast irons that offer unique combinations of properties. Applications and comparative service data in many industrial fields are presented to prove its utility in withstanding corrosion, heat, wear and low temperature.

Circle No. 14 on Postcard

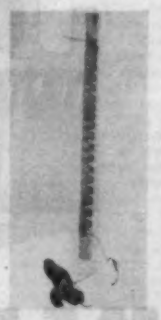
Blast-Cleaning Equipment

Vacu-Blaster is described as the only blast-cleaner equipment with dustless vacuum pickup that removes abrasives and debris simultaneously with operation. Vacu-Blast Company, Inc., makes this compact, movable blast-cleaning machine for use on metal, concrete, brick, stone or wood surfaces. It is described in a new catalog of the same title.

Circle No. 15 on Postcard

Flexible Heating Tape

Flexible Heating Tape for small glass vessels of standard or odd shape, such as distilling or fractionating columns, are made by Scientific Glass Apparatus Company, Inc. The tape produces high wattages without excessive heating of the wire. Danger of fire in the presence of inflammables is eliminated because tape properties are below the glow point. The tape consists of resistance wire covered with a double insulating sheath of white braided fiberglas yarn, complete with lead wires for connection directly to 110 volt current. Constant temperature may be maintained by utilizing a voltage regulator.



Circle No. 16 on Postcard

Protective Goggles

Made of plastic, this lightweight goggle manufactured by General Scientific Equipment Company, affords wide angle vision and may be worn over prescription glasses. One-piece construction with moulded rubber binding to fit natural contours of face, plus an elastic head band insures a snug fit and all day wearing comfort. It is recommended for protection against flying particles, sparks, splashes, etc. The goggles are identified as GS 100, clear glass; GS 200 green glass.

Circle No. 17 on Postcard

Liquid Level Gage

Jerguson Truscale Remote Reading Liquid Level Gages, published recently by Jerguson Gage and Valve Company, is available protective information on boilers, deaerating tanks, boiler feed water heaters, storage tanks, and for other installations where knowledge of the liquid level is important.

Circle No. 18 on Postcard

Purge Meters

Brooks Rotameters are presented in the new Brooks Rotameter Company bulletin. Designed to meet every purge meter requirement, they range from the inexpensive Brooks-Mite for small flow indication of liquids, etc., to high capacity and high pressure meters.

Circle No. 19 on Postcard

Tube Fittings

Swagelok Tube Fittings Catalog B-151 describes leakproof Swagelok tube fittings which are available in brass, aluminum, steel, stainless steel, and Monel, products of Crawford Fitting Company.

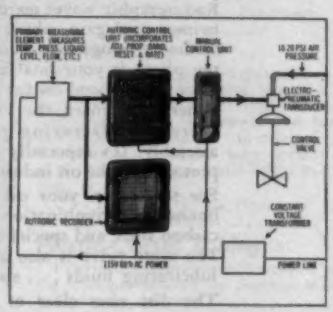
Circle No. 20 on Postcard

Air Drier

Vi-Speed Air Driers are a product of Van Products Company who recommend it to efficiently remove from compressed air and gases any moisture, oil, dust, dirt, etc. Its design is of simple, rugged construction with no moving parts, and contains no orifices to clog. Maintenance is simple because the device is self-cleaning, self-regulating and fully automatic. The only maintenance task is the addition of a small amount of filter material about once a month. Dryolite, the filter material, is inexpensive, according to Van Products, and never needs processing.

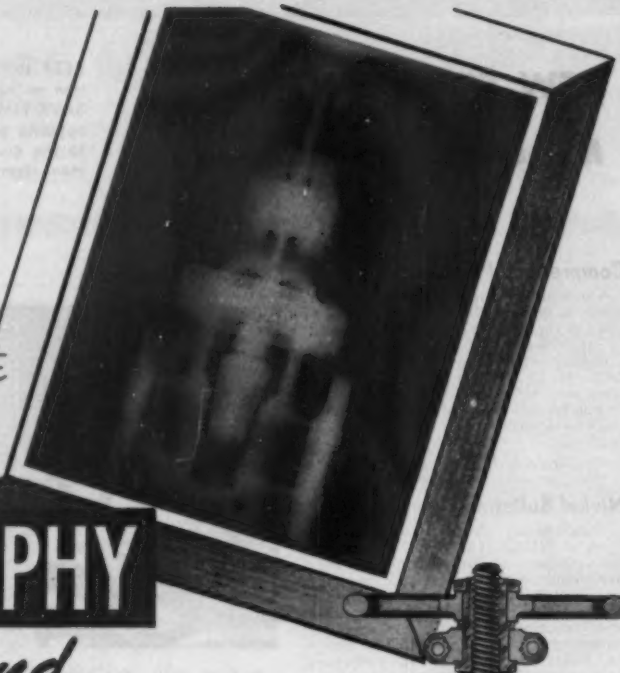
Circle No. 21 on Postcard

Automatic Control System



A new automatic all-electronic instrumentation and control system known as the Swartwout Autronic Control System is being manufactured by The Swartwout Company. The system is essentially three basic units: primary sensing element, autronic control unit, and final control element. It is powered by 115-volt 60-cycle alternating current. Since transmission of information throughout the system is by electrical means only, there is no transmission lag. The plug-in type Autronic control unit can be mounted at any convenient location so that all adjustments can be made at the graphic panel or central control point without the usual transmission lags. It includes provision for manual control as well as automatic.

Circle No. 22 on Postcard



RADIOGRAPHY

reveals sound

LUNKENHEIMER STEEL CASTINGS

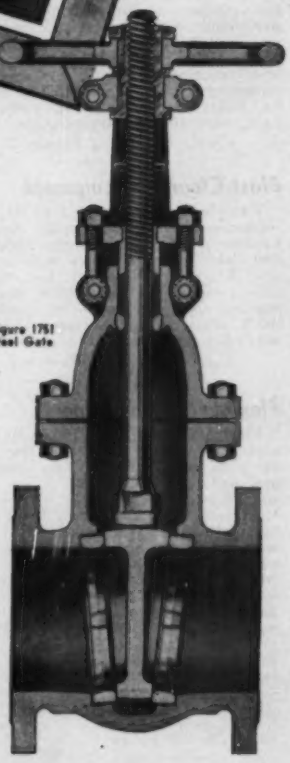
Radiographic waves search the internal structure of Lunkenheimer steel gate valves, exposing the dense, sound quality of their castings. The smooth tone of this short-wave gamma ray photo is your final assurance of soundness in the steel valve you depend on for round-the-clock petroleum service. Other tests guard the Fig. 1751 from imperfections after every manufacturing process — from foundry to final assembly. It's especially engineered and tested for 150 lb. pressures in the oil industry.

For service on your oil or oil vapor lines, specify body-bonnet-trim combination WB2. Body and bonnet are of cast carbon steel, and special oil-trim is of 13% chrome stainless. The same valve is also available for steam and other non-lubricating fluids . . . specify Fig. 1751 WB6.

The disc rises clear of the straight-through, streamlined port-to-port flow to minimize turbulence and pressure drop. Backseating faces let you repack the valve while it's wide open and under pressure.

Write for your free copy of "Lunkenheimer Oil Industry Valves," a circular in color describing more than fifty bronze, iron, and steel valves, "service engineered" for the petroleum industry. Address: The Lunkenheimer Co., Box 360G, Cincinnati 14, Ohio.

Figure 1751 Steel Gate



STEEL • IRON • BRONZE

LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

L-151-37

Weight Recorder

A weight determination instrument by The Streeter-Amet Company records weight records on ticker tape or even a ledger which is remote from the scale. Thus the president or superintendent can read the weight in his office the instant the product is weighed in the shipping department. The Ametron Electronic Scale utilizes electronic cells to transmit this information. The unit was developed by Streeter-Amet in combination with Baldwin-Lima-Hamilton Corporation. A brochure explains contruction, maintenance and installation.

Circle No. 23 on Postcard

Liquid Heat Transfer

A line of liquid phase heat transfer equipment to operate at temperatures up to 800° F. has been developed by the American Hydrotherm Corporation. They are offered as individual components adaptable to large industrial requirements, or as "tailored" package units.

Circle No. 24 on Postcard

Fire Tower

A portable device for discharging fire-smothering foam into a burning oil tank has been developed by Pyrene Manufacturing Company. Called a Pyrene Foam Tower, it claims mobility over rough terrain, ease and speed of erection by three or four men, and efficient delivery of large volumes of foam onto tanks up to 50 feet in height. The equipment is assembled in two sections; a base with unique screw-tilting gear mechanism and four spikes for use in case of rough ground; and a telescoped 20-foot, three-section tower with manual winch, two swivel-jointed push poles and stainless steel guy ropes. A six inch foam column ends in a heat-resistant stainless steel discharge head.

Circle No. 25 on Postcard

Protective Coating

Coal tar pitch has been compounded into a fast-drying protective coating by Flash-Stone Company, Inc., who break it down into minute molecules, then combine it with water and a stabilizing emulsification agent to form a permanent suspension that can be brushed or sprayed. "Tarlac," as it is called, is said to retain all the protective and adhesive qualities of coal tar pitch.

Circle No. 26 on Postcard

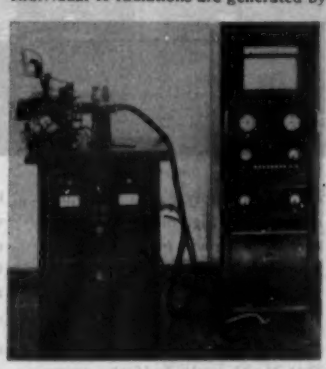
Pyrometers

Description of a new line of non-control pyrometers and resistance thermometers is contained in Minneapolis-Honeywell's new Bulletin 1051. These instruments use the same high resistance plug-in galvanometer unit and two-compartment case employed in the Pyr-O-Vane line, etc.

Circle No. 27 on Postcard

Fluorescent Analysis

The new Norelco Fluorescence Analysis Unit which is designed to facilitate rapid qualitative and quantitative analysis of constituents in metals, alloys, etc., is in production at the Research & Control Instruments Division of North American Philips Company, Inc. Specimens under analysis are exposed to an intense beam of exciting X-radiation. Individual X-radiations are generated by



elements susceptible to such excitation. Combined radiations representing the various constituents are passed through a special collimating system to a crystal serving as an analyzer and which, positioned, reflects each of the individual radiations at a specific angle. Data is evaluated in terms of percentages of the elements present.

Circle No. 28 on Postcard

Record Transmitter

Builders-Providence, Inc., has published a bulletin, "Chronoflo Telemeters," describing the instrument which makes possible the transmission of information and controls over a simple two-wire electrical circuit for unlimited distances.

Circle No. 29 on Postcard

Self-Priming Motor Pumps

Ingersoll-Rand Company has designed a self-priming motor pump for the petroleum industry. Intended for pumping applications under suction lift where the presence of air or vapor makes it impractical to use the conventional centrifugal pumps, they are especially suited to bulk station purposes for pumping liquids. Recirculating liquid trapped in the casing eliminates the necessity of filling the suction line and casing before starting.

Circle No. 30 on Postcard

First Aid

Fast relief for burns, sunburn, eczemas, and wounds is claimed for Americaine Aerosol, an automatic spray topical anesthetic manufactured by Americaine, Inc. Easy to apply, giving almost immediate relief, Americaine has been tested for safe medication by Americaine technicians.

Circle No. 31 on Postcard

Fractionating Tray

Koch Engineering Company has published a bulletin discussing and describing the new "Benturi" type Kaskade fractionating tray. Information on specifications, performance records of the Benturi-type Kaskade tray in distillation, absorption and liquid-liquid extraction, is included.

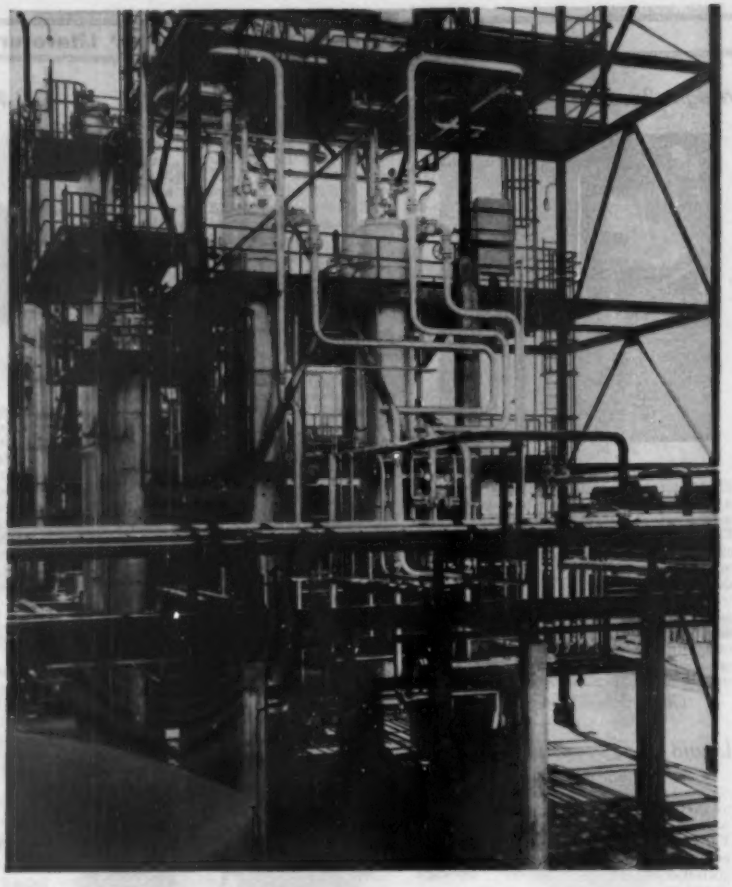
Circle No. 32 on Postcard

Plastic-Coated Tubing

Plastic armored electrical metallic tubing is manufactured by Samuel Moore & Company, for use where corrosive atmospheres necessitate frequent replacement of electrical conduit. This new Dekoron conduit is made by the patented extrusion process. A .020 inch coating of tough, corrosion-resistant vinyl or polythylene plastic is extruded over standard galvanized electrical metallic tubing. By varying the thickness and composition of the plastic armor, the conduit can be given any desired dielectric properties.

Circle No. 33 on Postcard

If it's Lummus-engineered, it's well-engineered.



Lummus Multilok Closures do multi-duty at Denver

Pictured (mid-photo) are two high-pressure catalyst reactors designed and fabricated by Lummus for Continental Oil Company's refinery at Denver, Colorado. These 4' 0" diameter x 35' 0" high vessels make unique use of the outstanding advantages of Lummus' patented Multilok Closures.

The reactors each employ 3140 sq. ft. of catalyst-packed tube surface to convert olefins in C_3 and C_4 hydrocarbons to poly-gasolines, under conditions of high-medium temperature and a pressure of 1200 psi on the tube side. Multilok Closures take the job in stride—providing sure, tight, trouble-saving, cost-saving performance.

But that's only half the story. Multiloks save valuable turnaround time when spent catalyst must be dumped and fresh recharged. With no heavy, hard-to-handle bolting involved (despite the high pressure withstood), Continental's operator is able to disassemble and reassemble the Multilok Closures in *less than three hours time.*

The Denver installation is a good example of Lummus' ability to design and build specialized shell-and-tube equipment. Too, it's a good example of Multilok Closures at their versatile best. There's a Lummus office near by to handle *your* next job.

THE LUMMUS COMPANY

HEAT EXCHANGER DIVISION • 385 MADISON AVENUE, NEW YORK 17, N.Y.

Atlanta • Boston • Chicago • Rock Island • Cincinnati • Detroit • Ft. Worth • Houston • Tucson • Salt Lake City • Minneapolis • Pittsburgh • Rochester • Albany • St. Louis • San Francisco • Wayne (Phila.) • Athens • Buenos Aires • Honolulu • London • Manila • Toronto • Paris • Rome • San Juan, P. R. • Mexico City

Steam Surface Condensers • Evaporators • Extraction Bleeder Heaters • Steam Jet Air Ejectors • Steam Jet Refrigeration • Barometric Condensers • Heat Exchangers for Process and Industrial Use • Process Condensers • Pipe Line Coolers.

Metal Cleaner

Magnus 751 is a new cleaner for all kinds of metal parts manufactured by Magnus Chemical Company. Non inflammable, the cleaner does not attack, pit, nor mar aluminum alloys, bearing metals, etc. It can be used in either hot or cold solution and is followed by a simple cold water rinse after the cleaning period. Magnus 751 meets military specifications.

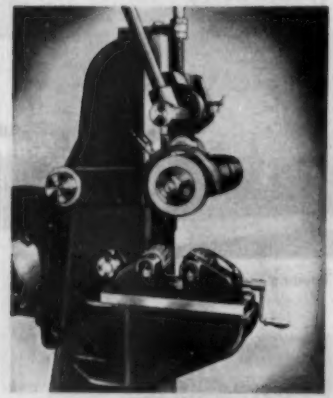
Circle No. 34 on Postcard

Mobile Spectrometer

Application, theory of operation and operating principle features of the Perkin-Elmer mobile infrared spectrometer is described in Minneapolis-Honeywell Instrumentation Data Sheet 10.16-4a. It is provided with the Brown ElectroniK recorder.

Circle No. 35 on Postcard

De-Scaling Attachment



A new pipe and tube De-Scaling and Cleaning Attachment for Steen Cut-Off machines has been manufactured by Continental Machine Company. The attachment cleans rust, scale, paint and other deposits off pipes, posts and building columns. It is especially adapted for reclaiming used pipes. Most work requires only one pass through the rollers to remove all deposits. Feeding up to 20 feet of pipe per minute, the device is suitable for both production and intermittent use. Sizes are available for cleaning pipes up to 12 inches in diameter.

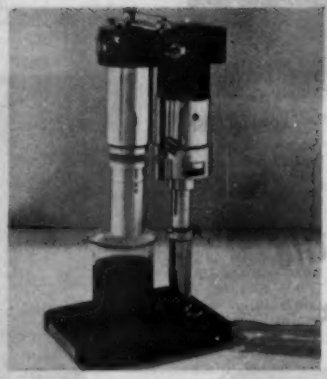
Circle No. 36 on Postcard

Submersible Pump

A submersible utility pump for industrial use is marketed by Kenco, Inc. The Kenco Automatic Liquid Level Control Switch eliminates the need for a float, and has no moving parts exposed to water. The switch turns the pump on automatically as a result of air pressure created by water rising in the switch skirt, moving a diaphragm, which in turn trips the switch.

Circle No. 37 on Postcard

Viscosimeter



Geophysical Machine Works has produced a new multi-speed, portable viscosimeter which is called the Fann V-G meter. It weighs nine pounds and may be operated from a six volt car storage battery. A rotational type instrument with five speeds, it permits sustained rates of shear for any desired period of time. Its measuring system employs a motor driven outer cylinder concentric with a stator. The fluid being tested occupies the annular space between the two, exerting a torque on the stator which is proportional to the viscosity of the fluid, when the outer cylinder is turned at a constant speed.

Circle No. 38 on Postcard

Copper Alloy Data

To help industry distinguish between copper base alloys, the Bridgeport Brass Company has published a folder which list 65 commonly used Bridgeport brass and copper alloys, along with their composition, properties, forms and uses.

Circle No. 39 on Postcard

Valve Seal

Essential operation of the new Rand Seal, manufactured by Rodic Chemical and Rubber Corporation, is based on working with the fluid flow. The cone-shaped seal is closed in the same direction as the movement of the liquid, allowing high or low pressures to seal the valve. The cup-shaped conical washer incorporates an imbedded metal plug which eliminates bending and warping and makes the seal leak-proof. If contaminants in the fluid, sand or grit, are not pushed ahead of one sealing line contact, the conical shape of the seal provides establishment of a new line contact without damage to the bore.

Circle No. 40 on Postcard

Vane Type Rotary Pumps

Worthington Pump and Machinery Corporation has added a heavy duty, vane type rotary pump to its line. All models are positive displacement, sliding vane types in which the pressure of the liquid being pumped maintains contact of the vanes against the liner. They are available in both internal and external bearing design, external models being especially suited for non-lubricating liquids such as gasoline and kerosine. The pumps contain built-in relief valve.

Circle No. 41 on Postcard

Metallizing Guns

Metallizing Engineering Company, Inc., expects its new metallizing guns will reduce machine part repair and salvage costs 85 to 90 percent, by making 25 to 30 year corrosion protection of equipment and structures available to more users. Metco Type 4E for machine element work, and Type 5E for corrosion protective coatings, are said to develop he highest spraying speeds yet available in guns designed for hand-held operation. They incorporate a patented jet siphon principle in the gas head which automatically compensates for variations in gas pressure as high as ten pounds.

Circle No. 42 on Postcard

Pyrometer Supplies

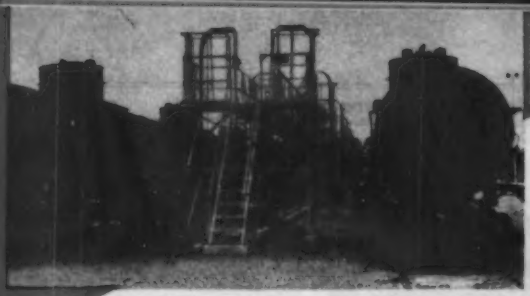
Pyrometer supplies manufactured by Minneapolis-Honeywell Regulator Company are described in their Catalog 100-4. The catalog furnishes technical data on application, and includes the complete line together with basic prices on standard Brown assemblies.

Circle No. 43 on Postcard

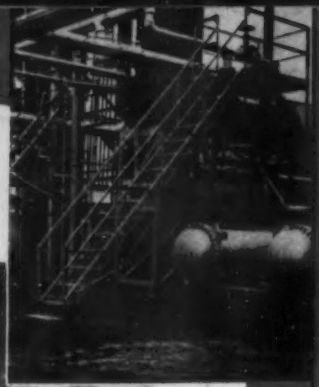
Drum Cleaning Unit

Fast, low-cost drum cleaning is described in a brochure published by the Pangborn Corporation. The Rotoblast technique cleans drums by throwing metallic abrasives against drum surfaces by centrifugal force.

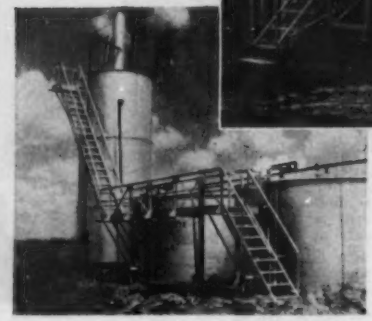
Circle No. 44 on Postcard



24-Car double track Type "A" Loading Rack



SAFWALK
Stairway and walkway
in Refinery



Stairway and double platform on tank battery

STRONG Versatile

Easy to Erect

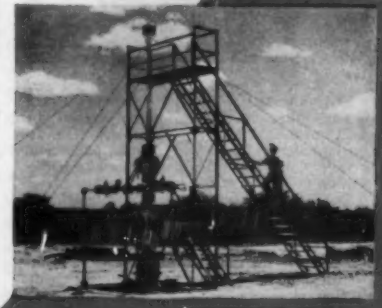
BS&B SAFWALK

STAIRS • WALKWAYS

PLATFORMS • LOADING RACKS

Pre-punched, pre-cut, precision made, BS&B SAFWALK Material lends itself to any type of stair, walkway or platform construction—to your own specifications or our design.
Easy-to-fit sections and joints, a vast assortment of sizes, makes SAFWALK material the most versatile and easy-to-erect method for such construction.
Its strength, safety and fireproof quality have contributed to the universal acceptance of BS&B loading racks by the oil and gas industry.
Write for full information—complete details and designs of SAFWALK construction.

8-Car Type G Loading rack built on a curve



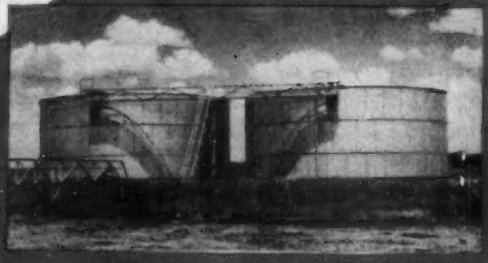
Special stairway and platform structure for 18 ft. Christmas Tree

BLACK, SIVALLS & BRYSON, INC.

Dept. 33-F Oil & Gas Equipment Division
2131 Westwood Ave. • Oklahoma City, Okla.

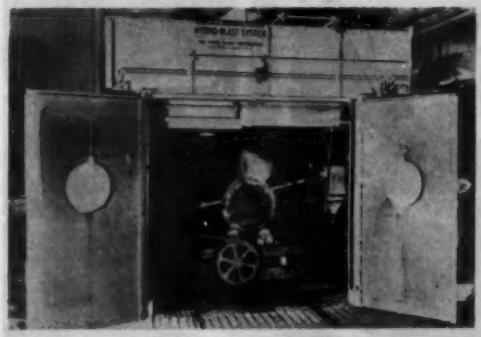
BS&B

10-Car Type H Loading Rack for underground Hydro-Carbon Storage



Walkway over firewall; stairs and platform on two 10,000 bbl. tanks

Power Cleaning



Hydro-Blast Corporation, a firm that utilizes a method of sandblasting, using water at 1000 to 2000 psi in which sand is entrained, has developed a new method of cleaning heat exchangers. It combines abrasive cleaning with the mining effect of high velocity water. The Hydro-Blast unit in the Esso refinery at Baton Rouge, La., is a roofed enclosure about 30 feet long, set on a suitable pit. Access doors for a work car are located at both ends. A 60-gpm gun is mounted on a carriage, moveable the length of the room, and about 4½ feet vertically and is mounted for 90 degree swivel. Sand ejected from the guns is washed into the pit.

Circle No. 48 on Postcard

Valves

The Valve Division of the American Car and Foundry Company has made available bulletin "A-C-F-Lubricated Plug Valves." This bulletin includes a description of the full pipe area wedgeless cylindrical plug, as well as others carried in the line.

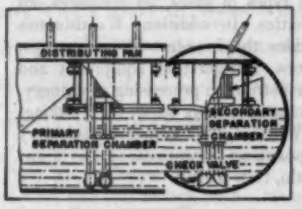
Circle No. 45 on Postcard

Protective Paints

Quick reference data is offered in The Wilbur & Williams Company technical folder describing preventive coatings for rust, chemical corrosion, and dampness. Coating types include rubber based paints, rust inhibitive paints, and vinyl coatings.

Circle No. 46 on Postcard

Dry Scrubber Purifier



Two-stage separation designed for use where solid free vapor is required is the big feature of The Centrifix Corporation's new dry scrubber purifier. Said to be capable of delivering vapor containing 1.0 ppm total solids or less, the unit provides internal upflow operation in pressure vessels such as steam drums. Auxiliary baffles within the drum are eliminated with this model. Primary stage separation is accomplished by means of a rectangular-shaped anti-turbulence shield which blocks direct contact of turbulent liquids and spray from the secondary separation chamber behind the shield. Secondary separation is accomplished with either upflow or downflow purifiers enclosed within the anti-turbulence shield.

Circle No. 47 on Postcard

Valves

Valves for boiler services are described in the new Everlasting Valve Company bulletin. It discusses quick-opening, slow-opening, angle "Y", and Duplex blow-off units, with specifications, materials of construction, and dimension included in each description.

Circle No. 49 on Postcard

Continuous Balance System

A description of the circuit and component characteristics of the amplifier and motor combination of the Brown "Continuous Balance" System is contained in this Minneapolis-Honeywell Regulator Company Bulletin B15-12.

Circle No. 50 on Postcard

Alloy Rods

Five new bulletins by Victor Equipment Company, Alloy Rod & Metal Division, are available and describe their complete line of hard-facing alloy rods.

Circle No. 51 on Postcard

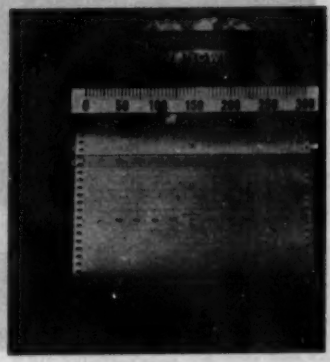
Fork Lift Trucks

Five new models have been added to the Towmotor Corporation line of Towmotor trucks. Three models have solid or cushion tires and a shorter wheel base for greater maneuverability. The other two feature pneumatic tires on all wheels. Model 480-P, pictured, has a 48 inch wheelbase, and can carry a capacity of 4000 pounds at 24 inch load center. Big, pneumatic tires assure rapid movement of loads over rough surfaces, indoors and out. "What Makes It Tick?" a 15 minute film released by Towmotor Corporation, shows basic fork lift truck construction and demonstrates newly developed features which meet new and unusual industrial requirements.

Circle No. 52 on Postcard

Scanning System

An electronic scanning system designed to automatically and continuously monitor up to 270 separate processing temperature points has been developed by Minneapolis-Honeywell Regulator Company. It records only those temperatures which deviate beyond a



pre-set limit and includes an audible alarm that permits immediate correction of excess temperatures. It cuts down the cost and use of several instruments, as well as time-taking logging operations and maintenance.

Circle No. 53 on Postcard

Controllers

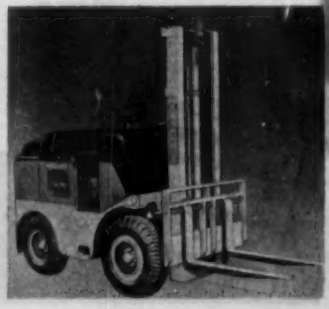
Moore Products Company has issued a new catalog, Bulletin 5011, on Nullmatic Controllers, M/P Control Stations, and Derivative Units. The cover section lists a complete summary of performance data on each instrument.

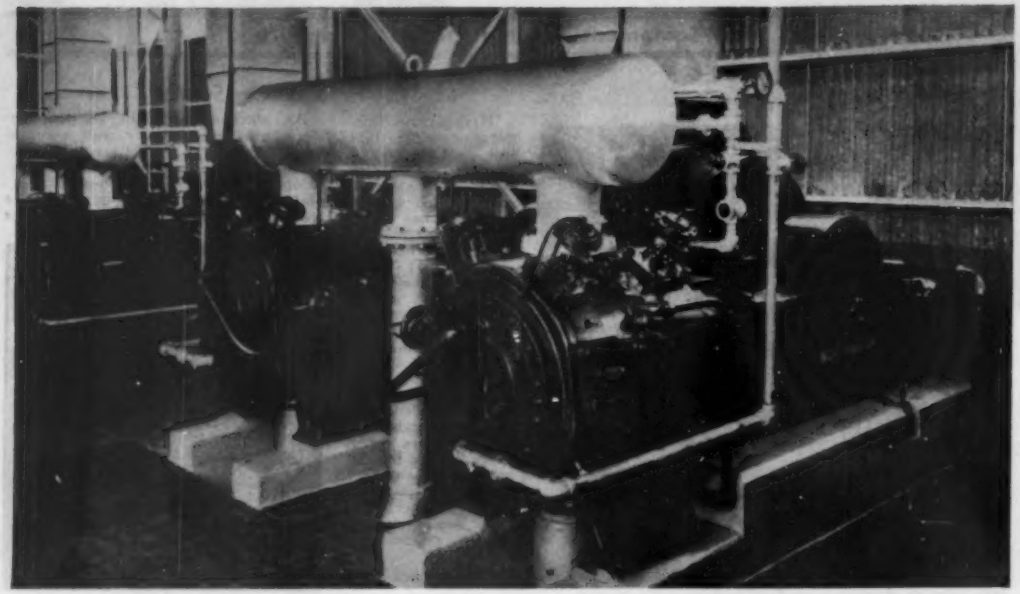
Circle No. 54 on Postcard

Inventory Control

A Booklet published as an aid to management by Remington Rand Inc. details the methods for utilizing their inventory control system for static stock record. Essential records are combined in one compact unit with visible signals.

Circle No. 55 on Postcard





A New Cracking System at Socony-Vacuum ...BUT THE SAME COMPRESSORS

When Socony-Vacuum needed to modernize its catalytic cracking plant in Buffalo, it put in the thermofor process.

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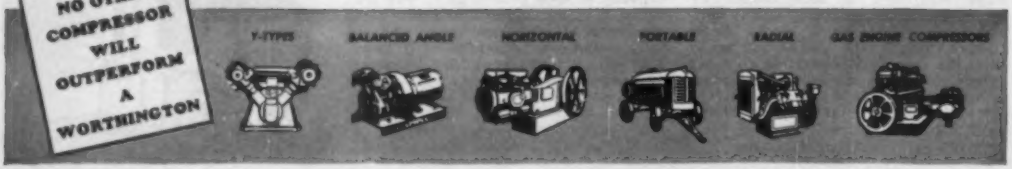

Catalogues, New Equipment Literature

Offered in this issue's advertisements. Use postcards opposite page 192

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GREASE MIXERS—Details. The Patterson Foundry & Machine Co. See page 239.
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CONDENSER TUBES—Booklet. Scovill Manufacturing Co. See page 33.
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SEMI-STEEL TRAPS—Catalog 68-R. Strong, Carlisle & Hammond Co. See page 222.
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TUBE CLEANER—Bulletin. Thomas C. Wilson, Inc. See page 212.
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CENTRIFUGAL PUMPS—Bulletin. Worthington Pump & Machinery Corp. See page 90.
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STEAM TRAPS—Booklet. Yarnall-Waring Co. See page 245.
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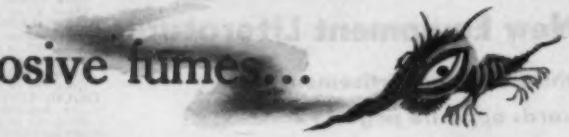

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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

Fundamental Physical and Chemical Data

Volumetric and Phase Behavior in the Ethane-Propene System, R. A. McKay, H. H. Reamer, B. H. Sage, and W. N. Lacey. *Ind. Eng. Chem.*, **43** (1951), pp. 2112-7.

The investigation was concerned with the establishment of the volumetric and phase behavior of the ethane-propene system. The moral volume of three mixtures of ethane and propene was measured at pressures up to 10,000 psi. in the temperature range 10° to 400° F. The composition of the coexisting phases was established through the two-phase region of this system at temperatures above 10° F. The deviations from ideal solutions are relatively small and confirm the idea that hydrocarbon mixtures show relatively simple volumetric behavior at high pressures. The equilibrium ratios for the components follow the pattern found for other hydrocarbon systems. The deviation from ideal solutions and from the behavior of these same components in other binary systems was found to be significant.

The Solubility of Propane and the Butanes in Ethanol, Carl B. Kretschmer and Richard Wiebe. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 3778-81.

The work was undertaken to obtain a more accurate and complete picture of the solubility relationships of the lower hydrocarbons in alcohol. The solubility of propane, n-butane and isobutane in ethanol was measured at temperatures from 0° to 50° C. and at pressures up to one atmosphere. Second virial coefficients of these gases were measured at 30° C. An equation was fitted to the solubility data. Data are reported as mole fractions of hydrocarbons at a given total pressure. Partial molal excess free energy and entropy and the partial molal heat of mixing at infinite dilution were calculated. The solutions exhibit large positive deviations from Raoult's law, and it was found that the excess partial molal entropies are negative.

Limits of Flammability of Paraffin Hydrocarbons in Air, M. G. Zabetakis, G. S. Scott, and G. W. Jones. *Ind. Eng. Chem.*, **43** (1951), pp. 2120-4.

Data on the lower limits of flammability were obtained for the paraffin hydrocarbons at varying elevated temperatures. These data indicate an average decrease of eight percent in the lower limits of flammability of paraffin hydrocarbons for a corresponding temperature increase of 100° C. On a weight basis, small variations for any constant temperature suggest the use of a gravimetric method in determining the explosibility of an atmosphere containing paraffin hydrocarbons. The authors describe such a method and discuss its limitations. A table showing the lower limits of flammability of 22 paraffin hydrocarbons is included for reference.

Chemical Composition and Reactions

Chemistry of the Non-Benzenoid Hydrocarbons, B. T. Brooks.

The first edition of Dr. Brook's book appeared in 1922 and urged the systematic study of the hydrocarbons derived from petroleum, just as the hydrocarbons derived from coal tar had been exhaustively studied in the last 50 years. In preparing the book the literature through 1949 has been thoroughly covered and references are given to important facts as well as published articles. The first chapter deals with the composition and origin of petroleum. The next five chapters are concerned with the paraffin hydrocarbons, including methods of preparation and reactions. The following five chapters deal with the olefins, covering preparaiton, isomerization, polymerization, alkylation, oxidation and other chemical reactions. A chapter is included on the reactions of the dienes, trienes and polyenes. A brief chapter is included on the acetylene hydrocarbons. The final chapter in the book deals with the cycloparaffins and is mainly concerned with the terpenes and other hydrocarbons from natural products.

Aluminum Bromide Isomerization of 2,2,4-Trimethylpentane Alone and in the Presence of Naphthenes. Mechanism of the Inhibition by Naphthenes of Side Reactions During Paraffin Isomerization, Francis E. Condon. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 3938-47.

The aluminum bromide isomerization of 2,2,4-trimethylpentane at 26° C. gave 18 percent isobutane, 6 percent isopentane, 12 percent hexanes and heptanes, 26 percent isomeric octanes and 38 percent heavier products, including the catalyst sludge oil. These yields were practically unchanged in the presence of trans-decalin or cyclohexane. However in the presence of cis-decalin or methylcyclopentane, the yield of isomers increased regularly with the initial quantity of added naphthene and the yields of other products, except isobutane, were correspondingly reduced. Cis-decalin, however, was simultaneously isomerized to trans-decalin and methylcyclopentane was isomerized to cyclohexane. But the isomerization of cis-decalin is 46-49 times as fast as that of methylcyclopentane. Thus, in addition to being less effective as an inhibitor of side reactions, trans-decalin was much more less reactive than cis-decalin in aluminum chloride-catalyzed halogen-hydrogen exchange with t-butyl chloride at 1° C. A mechanism is proposed for the inhibition by naphthenes of side reactions during paraffin isomerization.

Liquid Complexes of Lower Olefins with Anhydrous Metal Salts, Alfred W. Francis. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 3709-13.

Although solid compounds of olefins, such as ethylene, propylene and isobutene, with anhydrous copper, mercury and silver salts are known, there is no mention in the literature of a liquid complex compound of an olefin with an anhydrous metal salt, except those of the halides of amphoteric elements, such as aluminum. In the present study anhydrous silver nitrate was agitated with liquid propylene under pressure and was found to give a separate liquid phase of unusual properties. A similar liquid complex is formed with 1-butene. Complexes contain 1.3 moles of olefin per one mole of salt. They are stable only under pressure near the vapor pressure of the olefin, and below 36° and 25° C., respectively, for propylene and 1-butene. At lower pressures or higher temperatures evolution of the olefin is complete. Propylene was found to form an equimolar liquid complex with anhydrous mercuric acetate. This liquid, however, does not evolve propylene under vacuum or with moderate heating, but does so when hydrochloric acid is added. Phase diagrams of the several systems studied are given.

Dehydrogenation of Methylcyclopentane Over Chromia-Alumina Catalysts, Heinz Heinemann. *Ind. Eng. Chem.*, **43** (1951), pp. 2098-2101.

The investigation was made in an ef-

These abstracts are selected from the current literature of science and technology, not including trade journals easily available. Photostatic copies of original article will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also will be prepared and furnished by arrangement with the Laboratories.

HAVING TROUBLE PUMPING HEAVY OILS?
CONCERNED ABOUT LOSSES RESULTING FROM VOLUME SHRINKAGE AT LOW OIL DELIVERY TEMPERATURES? ...THEN INSTALL

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TANK SUCTION HEATERS

TO SOLVE YOUR PROBLEMS

TANK SUCTION HEATER INSTALLATION

The shell is open at the inside end. The oil moves across the heating tubes as it passes through the shell to the suction connection outside the tank.

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WITH PARACOIL TANK SUCTION OIL HEATERS

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- Overall Steam Consumption And Heating Costs Are Held To A Minimum.
- Heater Tube Bundle Can Be Withdrawn For Inspection And Cleaning. Breaking of oil suction line not necessary.
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- U-Tube Design Permits Free Expansion And Contraction Of Tube Bundle. Either high or low pressure steam can be used as the heating medium.

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Our extensive stocks of tubing and pipe enable us to make quick deliveries to meet your immediate requirements.
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SPEED UP DELIVERIES AND CUT OIL VOLUME LOSSES WITH PARACOIL TANK SUCTION HEATERS

In addition to the Paracoil Tank Suction Heaters, we also design and fabricate Line Type Discharge Heaters of any capacity. Illustrated is a Paracoil Straight Tube Type Fuel Oil Heater for bulk station service—capacity 2,000 gallons per minute, No. 6 oil, 100°F to 160°F, steam at 15 psig. Weight 12 tons.

DAVIS ENGINEERING CORPORATION
1060 East Grand Street, ELIZABETH 4, NEW JERSEY
30 Rockefeller Plaza, NEW YORK 20, N. Y.

fort to produce cyclohexene from petroleum fractions. Dehydrogenation at atmospheric pressure of methylcyclopentane over chromia-alumina catalysts in the presence of hydrogen and a small amount of benzene gives better yields of mono-olefins and less coke than either dehydrogenation at reduced pressure in the absence of hydrogen and benzene, or dehydrogenation in the presence of hydrogen or benzene individually. More than enough hydrogen and benzene are made in the process to make the process self-sufficient for these materials. The results obtained can be varied by selectively treating or poisoning the dehydrogenation catalyst.

Rates and Temperature Coefficients in the Hydration of Gaseous Isobutene by Dilute Aqueous Nitric Acid. JOSEPH H. LEVY, ROBERT W. TAFT, JR., DAVID AARON AND LOUIS P. HAMMETT. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 3792-7.

The authors developed a method for measuring the rate of reaction of a gaseous olefin with an aqueous acid solution by use of which the rate of reaction of the olefin at unit fugacity can be determined with a probable error of one percent or less. This procedure has been applied to the reaction of isobutene with 0.1 and 1 molar nitric acid. The energies of activation so determined over a 20 degree range have a probable error of 0.13 kcal. Because of uncertainties about the distribution of olefin between solution and gas phases the rates cannot be directly compared with previous measurements of the rate at unit concentration of the dissolved olefin.

Substitution Products of the Isomeric Thiophthenes. The Structure of Liquid Thiophthen (Thiopheno-2′:3′:2:3 - Thiophen), FREDERICK CHALLENGER AND ROBERT EMMOTT. *Jour. Inst. of Petroleum*, **37** (1951), pp. 396-405.

The structure of liquid thiophthen is shown to follow from two observations. First, the nitration of methyl ketone and the action of acetyl chloride and aluminum chloride on the nitro-thiophthen yield identical nitro-keytones and hence identical oximes; and second, that oxidation of the methyl ketone to carboxylic acid, nitration, and decarboxylation yields the same nitro-compound as is formed by direct nitration of liquid thiophthen.

The Reaction of Dinitrogen Tri- and Tetroxides with Olefins. 2-Ethylbut-1-ene and Dec-1-ene, C. R. PORTER AND B. WOOD. *Jour. Inst. of Petroleum*, **37** (1951), pp. 388-95.

Reactions of olefins with nitrogen oxide have been studied for the purpose of characterizing, and of determining the positions of double bonds in olefins. Nitrogen tetroxides and nitrogen trioxides were found to give different products when reacting with 2-ethylbutene and with decene.

Polyethylene - Structure, Crystallinity and Properties, R. B. RICHARDS. *Jour. of Applied Chem.*, **1** (1951), pp. 370-6.

Polyethylene can be regarded as the parent of the vinyl family of polymers, and the properties of such polymers as polystyrene, polyisobutene and polytetrafluroethylene can be discussed in terms of the effect of the substitution of hy-

If SOUR CRUDE is your problem

The Tannin Solutizer Process* may be your answer

AS MORE AND MORE SOUR CRUDE must be refined, the advantages of this mercaptan-removal process become increasingly attractive.

This is the process that replaces doctor treating and reduces TEL requirements . . . without affecting either the quality or the stability of the treated gasoline.

Converting to the Tannin Solutizer Process requires a minimum investment in new equipment . . . very likely your present equipment will serve with little change.

Operating economy is an outstanding advantage of the Tannin Solutizer Process . . . *this process is not corrosive*, does *not* require equipment of special alloys.

Complete engineering service is available . . . to help plan your unit, to supervise start-up, to assist in later operation if required. We welcome the opportunity to work with you in extending the benefits of the Tannin Solutizer Process.

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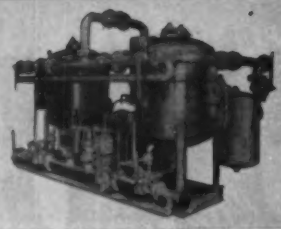

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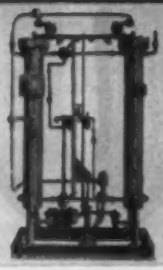

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drogen atoms in polyethylene by other groups. The present paper, however, is concerned with the variation in the physical and mechanical properties of polymers produced from ethylene alone under different polymerizing conditions of temperature and pressure. A wide range of polymers can be made including oils, greases, soft and hard waxes and plastics both softer and harder than the familiar type of polymer used for electrical insulation and film. Some of these property changes are caused by changes in average molecular weight. However, there are variations at the same molecular weight. These are caused by differences in structure of the polymer molecule. Many of the properties of the solid polymer are determined by the degree of crystallinity. This is not affected much by average molecular weight, but is dependent largely on the degree of chain branching. The measurement of chain branching and its effect on crystallization are discussed. The influence of average molecular weight and molecular structure on several properties, including cracking in organic liquids, is described. The importance of the arrangement of the crystalline regions is stressed. A bibliography of thirteen references is included.

The Preparation and Properties of Sulfur Compounds Related to Petroleum. I. The Dialkyl Sulfides and Disulfides, D. T. McAllan, T. V. Cullum, R. A. Dean and F. A. Fidler. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 3627-32.

Although the bad effects of some of the sulfur compounds of petroleum products are well known and many refinery processes have been developed for removing them, yet the fundamental knowledge of their chemical properties is limited. The present work was part of the program designed to assist in filling this gap. It was confined to the synthesis of those sulfur compounds that have been identified in straight run distillates. Thiophenes and unsaturated sulfur compounds were not included. The authors report on the preparation of fourteen dialkyl sulfides and eleven dialkyl disulfides. The physical properties of the compounds are given. For purposes of charactirizing the compounds, mercuric chloride derivatives and sulfones were prepared from the sulfides. Under certain conditions, a mixture of two symmetrical disulfides will disproportionate to give an equilibrium mixture containing the unsymmetrical compound. This reaction was found to be useful for the preparation of certain of the unsymmetrical disulfides.

The Preparation and Physical Properties of Sulfur Compounds Related to Petroleum. II. Cyclic Sulfides, E. V. Whitehead, R. A. Dean and F. A. Fidler. *Jour Am. Chem. Soc.*, **73** (1951), pp. 3652-5.

The first paper in this series dealt with the syntheses and physical properties of the alkane sulfides and disulfides. The preent paper deals with another class of organic sulfur compounds found in straight-run petroleum distillates, namely, the saturated cyclic sulfides. The only cyclic sulfides that have been identified in or isolated from petroleum distillates have contained either 5- or 6-membered rings. The most interesting sulfide prepared was 2,5-dimethylthiacy-

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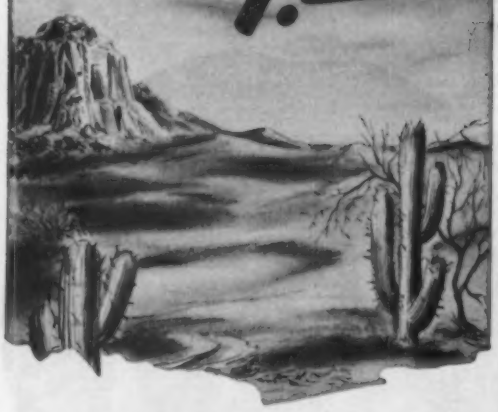

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clopentane. This compound can exist in cis and trans modifications and both forms were synthesized in reasonably high and known degree of purity for the first time. Other compounds prepared were thiacyclopentane, 2- and 3-methylthiacyclopentanes, thiacyclohexane and 2-, 3-, and 4-methylthiacyclohexanes. As in the case of the straight-chain sulfides, derivaties were prepared to assist in the characterization of the new compounds. The three derivatives used were the methiodides, the sulfones and the stable mercuric chloride complexes.

Separating Asphalt into Its Chemical Constituents, GORDON O'DONNELL. *Analytical Chem.*, **23** (1951), pp. 894-8.

Compared to the information available on overhead distillate products from petroleum, there is almost nothing known of the chemical composition of asphalt. The work described covers a separation procedure for asphaltic compounds, comparable to the analysis of overhead cuts. The purpose was to separate asphalt into a limited number of groups of components, each including definite chemical classes of compounds and compounds of definite molecular weight. A California coastal asphalt was selected for study. The method used included molecular distillation to yield a size separation; silica gel chromatography to separate saturates, aromatics, and resins; solvent dewaxing of the saturates to determine wax content; urea-complex formation to separte long-chain paraffins; alumina chromatography to separate monocyclic aromatics; peroxide oxidation followed by chromatography to remove thiophene analogs; and thermal diffusion in the liquid state to segregate naphthenes on the basis of ring numbers. The procedure has proved to be satisfactory for establishing the concentration of paraffins, naphthenes, aromatics, resins, and asphaltenes in asphalt, as well as the distribution of these classes of compounds on the basis of molecular size.

Manufacture: Processes and Plant

Chemical Engineering Unit Processes. *Ind. Eng. Chem.*, **43** (1951), pp. 1893-2022.

The annual chemical engineering unit processes review of Industrial and Engineering Chemistry covers several subjects or fields of work of interest to the petroleum engineer, including reviews of the following subjects: kinetics and equilibria, alkylation, amination by reduction, ammonolysis, combustion, esterification, Friedel-Crafts reactions, halogenation, hydrogenation and hydrogenolysis, nitration, oxidation, polymerization, pyrolysis of coal and shale, pyrolytic and catalytic decomposition of hydrocarbons, and sulfonation and sulfation. This is the fourth annual Unit Process Review.

Countercurrent Solid-Gas Fractionation Process. ALLEN F. REID. *Ind. Eng. Chem.*, **43** (1951), pp. 2151-3.

The process described is analogous to fractional distillation in which a vapor phase and a liquid phase are countercurrently contacted. A comparable type of separation between gas and solid phases can be expected in any single stage. However, no practical method has

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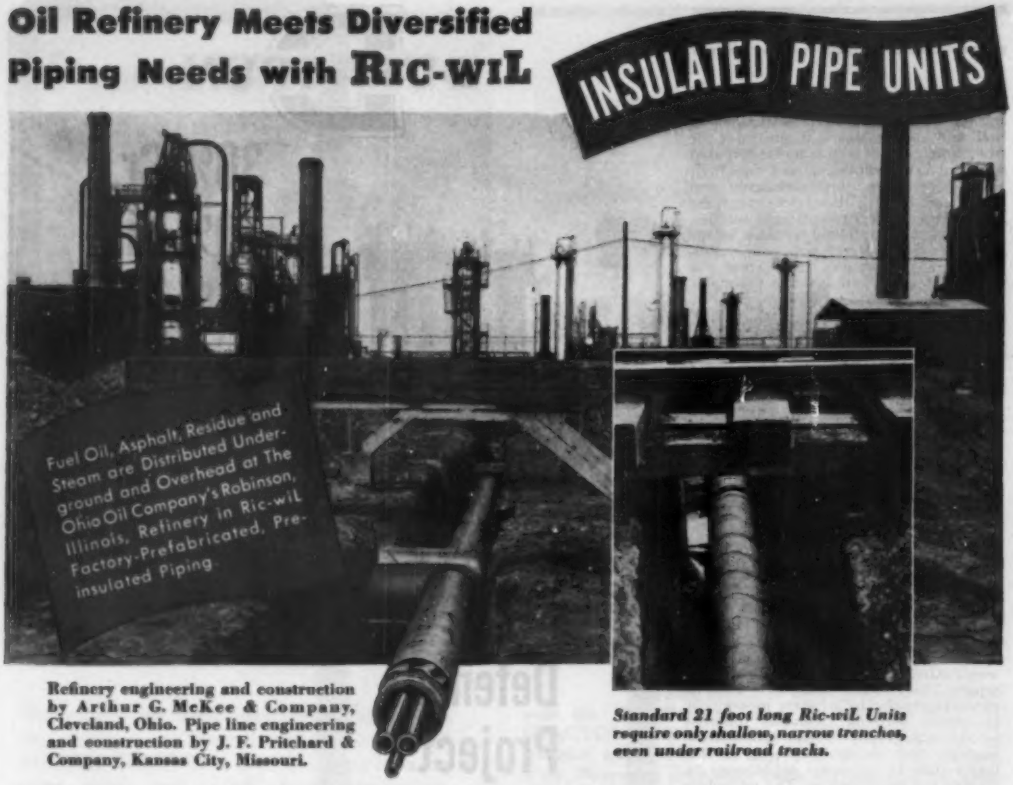
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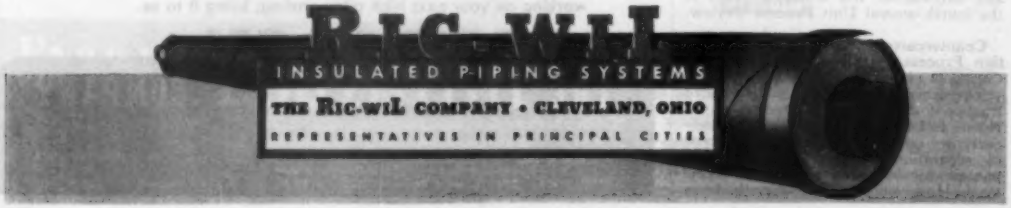

been available to provide continuous countercurrent motion of the phases similar to that used in fractional distillation. The method described by the author provides such countercurrent motion by means of unidirection motion of a series of alternate cold and hot regions along an extended passage that contains the mixture to be fractionated. The apparatus used was a helical tube of six turns, rotated on a horizontal axis partially submerged in the coolant with vaporizing heat applied to the upper part. For a benzene-cyclohexane mixture at proper operating conditions a separation factor of over 100 was consistently realized. From this and other fractionations that were accomplished, it appears that separation of vaporizable solids is feasible in multistage systems. In some instances such fractionations can be economically practiced.

Effect of Pressure Drop on Distillation Plate Calculations, ALLEN M. ESHAYA. *Ind. Eng. Chem.*, **43** (1951), pp. 2153-5.

In the usual methods of evaluating the performance of distillation columns the pressure is assumed to be constant throughout the column. This assumption is satisfactory in atmospheric pressure operations, but may lead to serious errors in low pressure distillations where the pressure drop of a plate may be the substantial fraction of the total pressure. A method is presented for the establishment of an equilibrium curve corrected for variations in pressure throughout the column. By application of this correction factor at several points of the equilibrium curve, one can take into account the effect of pressure drop on the vapor-liquid equilibrium relationships of the system. Although of possibly limited practical importance, the method should be helpful in research work where the variables that affect column performance at low pressures are being studied. The procedure permits a more accurate calculation of the number of theoretical plates than has hitherto been possible.

Urea Extractive Crystallization of Straight-Chain Hydrocarbons. WM. A. BAILEY, JR., R. A. BANNEROT, L. C. FETTERLY, AND A. G. SMITH. *Ind. Eng. Chem.*, **43** (1951), pp. 2125-9.

The formation of crystalline complex compounds between urea and normal paraffins has been reported and studied by several authors. The purpose of the present work was to study a continuous process developed to utilize the urea reaction in practical large scale separation of straight-chain hydrocarbons from petroleum fractions. The name "extractive crystallization" has been adopted for this new type unit process. The process has been developed in a pilot plant of 2 barrels per day capacity, and the results indicate that continuous operation on a commercial basis will be practical. In the pilot plant work nearly complete removal of n-paraffin hydrocarbons was accomplished except for low boiling feed stocks, and extracts of better than 95 percent n-paraffin content were produced in a single stage. The process can be potentially applied in the production of n-paraffins, in the recovery of straight-chain olefins from cracked stocks, in the pour point reduction of oils and fuels, and in octane number improvement. A

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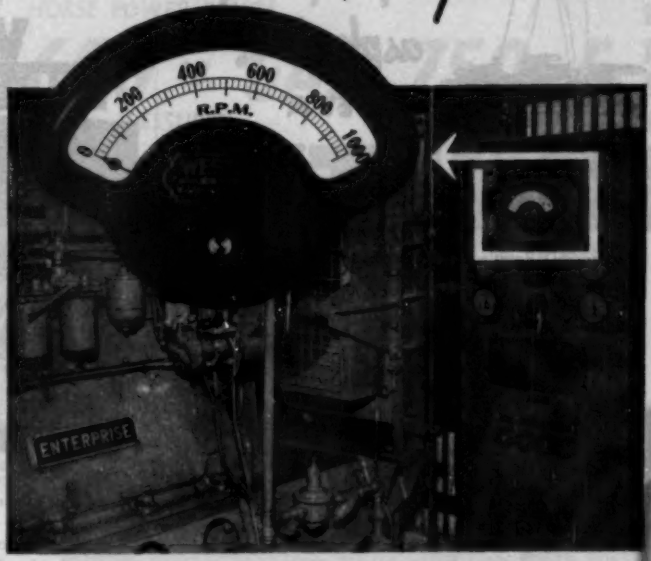

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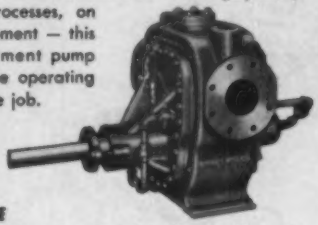

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bibliography of nine references is included.

Platforming of Pure Hydrocarbons, VLADIMIR HAENSEL AND GEORGE R. DONALDSON. *Ind. Eng. Chem.*, **43** (1951), pp. 2102-4.

The investigation had to do with the reactions of pure hydrocarbons under the conditions of the so-called Platforming process. It was found that n-heptane isomerizes and hydrocracks to a large degree. The principal products from hydrocracking are propane and isobutane. When heating n-pentane isomerization to isopentane is the principal reaction. Isopropylbenzene, or cumene, hydrocracks to propane and benzene. Benzene, in turn, goes to cyclohexane and methylcyclopentane. Simultaneously, appreciable amounts of isomeric C_8 aromatics and lesser quantities of isomeric C_8 naphthenes are formed. The yields of toluene and xylene are low. Methylcyclohexane goes to toluene and isomeric alkylcyclopentanes. Under proper conditions it is possible to convert methylcyclohexane almost quantitatively to toluene.

Intraparticle Diffusion in Catalytic Heterogeneous Systems, NORMAN L. SMITH AND NEAL R. AMUNDSON. *Ind. Eng. Chem.*, **43** (1951), pp. 2156-67.

The objective of the work was to determine the effect of intraparticle diffusion in catalytic heterogeneous systems and to determine its relative importance in connection with the over-all rate process. Formulas are derived that take into account diffusion of reactants and products, reaction rate, and mass transfer at the particle surface for three types of reactors: one, well-agitated continuous flow reactor, two, packed tube continuous reactor, and three, batch reactor. The reaction assumed is a simple reversible reaction of the first order in each direction and takes place inside the particle. The equations derived related the physical and chemical parameters of the system to the operating variables. The particular reaction studied to obtain experimental confirmation of the derivation was the hydrolysis of a simple ester, ethyl formate. The catalyst used was Dowex 50, a cation exchange resin. In general the experimental work confirms the validity of the equation. It is believed that the formulas should be of value in theoretical kinetic studies as well as in the design of commercial reactors. The work indicates that diffusion can be a factor in some heterogeneous processes. A bibliography of 18 references is included.

Corrosion Experiments With Gaseous Boron Trifluoride, F. HUDSWELL, J. S. NAIRN AND K. L. WILKINSON. *Jour. of Applied Chem.*, **1** (1951), pp. 333-41.

Several constructional materials, metals, alloys and miscellaneous compounds may be required to come into contact with boron trifluoride which is an extremely reactive gas. It is rapidly attacked by traces of moisture to give hydroxyfluoboric acids and hydrogen fluoride, so the reactivity of hydrogen fluoride must be reckoned with if moisture is present. In the present work boron trifluoride of very high purity was used. Materials studied were examined by bringing them into contact with gas at an original fixed pressure of about 25 cm. of mercury, and at a temperature of 200° C. The extent of the reaction, if

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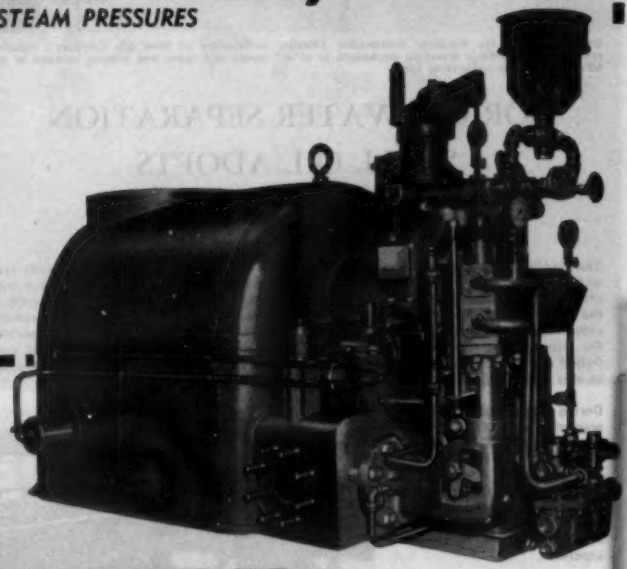

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Overall view of the Hardinge Rectangular Clarifier installation at Shell Oil Company's Houston refinery. The Hardinge traveling mechanism is 41'-6" across and spans two settling sections of the 60'-long oil-water separating tank.

FOR OIL-WATER SEPARATION SHELL OIL ADOPTS HARDINGE CLARIFIER

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The Hardinge Rectangular Clarifier (shown above) is in service in one of the gravity type oil/water separators at Shell Oil Company's Houston Refinery. The traveling carriage with attached duplex sediment scrapers is mounted on rails supported by the concrete walls of the separator and extending the length of the settling sections. A flexible electrical cable supported on pulleys supplies current to a one horsepower motor which operates the carriage and assemblies. This clarifier, designed for continuous operation, is controlled automatically, requiring the attention of the operator only in starting and stopping as may be desired.

During normal operation of the separator, Shell Oil finds it necessary to operate the Hardinge clarifier for only two hours each day. Following a period of heavy rainfall the period of operation is extended for removal of additional amounts of solids and slop oils entering the separator.

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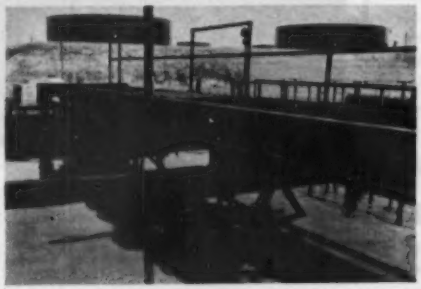

Close-up view of the Hardinge traveling mechanism, showing skimmers removing floating oil from the surface. This carriage also supports the sludge scrapers which remove the sediment from the bottom of the settling tank.

Sediment and sludges which accumulate on the floor of the separator are transferred by the duplex scrapers to sediment sumps recessed in the concrete floor of the separator and from which they are removed by sludge pumping facilities. Duplex skimmer blades move the slop oil at the water surface to slotted pipe skimmers which remove this oil from the separator. The maintenance of a clean separator by effective removal of sediment and slop oil using the Hardinge clarifier mechanism is a significant factor in efficient performance of the separator.

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Science and Technology

any, was shown by the alteration of the gas pressure. Several materials showed a high resistance to chemical attack by boron trifluoride and it was concluded that the following materials can be safely used in apparatus for handling this compound: stainless steel, mild steel, copper, nickel, Monel metal, brass and aluminium, the more noble metals up to at least 200° C., Pyres glass up to 200° C., fired pyrophyllite and polytetrafluoroethylene up to 80° C. Great variation was observed in the attacks on various other compounds.

Products: Properties, Utilization and Analysis

Viscosity Index Improvers for Lubricating Oils Polyvinyl Esters of Long-Chain Fatty Acids, WILLIAM S. PORT, JAMES W. O'BRIEN, JOHN E. HANSEN, AND DANIEL SWERN, *Ind. Eng. Chem.*, **43** (1951), pp. 2105-7.

Polymers and copolymers of vinyl esters of the long-chain fatty acids are potentially of commercial interest because the monomers can be readily prepared in high yield from inexpensive and available raw materials. These polymers and copolymers were tested as viscosity index improvers for lubricating oils. It was found that polyvinyl palmitate, polyvinyl caprylate, and copolymers of vinyl palmitate with vinyl acetate are effective viscosity index improvers. The extent of improvement by copolymers increases with increased vinyl acetate content. However, the solubility of the copolymers in lubricating oils decreases as the vinyl acetate content increases. The optimum effect is obtained with a copolymer containnig about 25 mole percent of vinyl palmitate. In general the viscosity index-improving effect of a polymer or copolymer is enhanced as the solubility of the polymer decreases and its concentration increases.

Water in Transformer Oil—A Critical Résumé of the Causes and Effects of Water in Oil-Filled Transformers, M. R. DICKSON. *Jour. Inst. of Petroleum*, **37** (1951), pp. 373-87.

The presence of water in an oil-filled transformer is generally, and properly, regarded with disfavour. However, the transformer need not give trouble when quite large quantities of water are present. It is the purpose of the paper to help to clarify this apparent anomaly and to place the formation of water and the effects of water in transformers in correct perspective. Water may enter transformers accidentally, by chemical reaction in the oil, or by absorption of water vapour from the atmosphere. These sources of water are discussed. Oil in a transformer fulfills two primary purposes: first, removing heat from the windings and core and disposing of it elsewhere, and second, assisting in the insulation of the windings. The cooling qualities of an oil are not directly affected by moisture. The electrical qualities are, however, often greatly affected, even by traces of moisture. The effect of water on the breakdown strength is discussed, as well as the effect of water on resistivity and power factor. Water may also be absorbed by fibrous insulating materials and it may lead to the corrosion of

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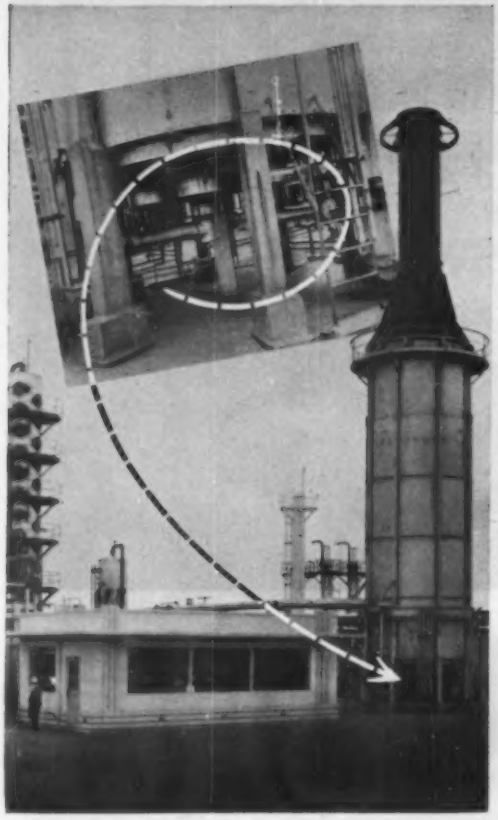

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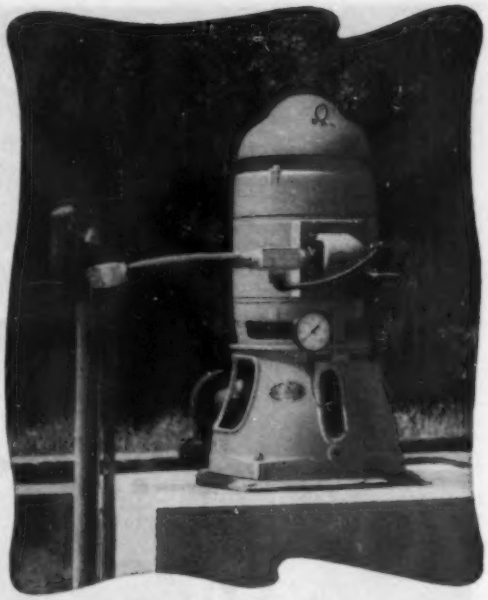

FOR THE CITY OF TOMS RIVER, New Jersey

With her population more than doubling during the summer season, the resort city of Toms River, New Jersey, was facing a serious water shortage. Five old, inefficient and not too dependable wells were being operated with suction pumps.

Layne was called in for a discussion of what could be done with limited funds. Layne's recommendations resulted in a contract for the rebuilding and re-equipping of one old well and the drilling and equipping of a new one. The contract also called for an auxiliary, gasoline engine drive on one of the pumps for use in case of electric power failure. Without delay everything was finished according to the contract, giving the city of Toms River a water supply that more than fulfills their present needs.

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steel and possible attack on non-ferrous metals. A bibliography of 52 references is included.

Mass Spectrometry of Heavy Hydrocarbons, M. J. O'Neal, Jr., and T. P. Wier, Jr. *Analytical Chem.*, **23** (1951), pp. 830-43.

The purpose of the work done was to provide a means for examining the mass spectra of heavy hydrocarbons, and to determine and correlate structure and spectral characteristics of a limited number of pure compounds. To accomplish this a Consolidated Engineering Corporation analytical mass spectrometer was used and modified to provide complete resolved spectra of compounds having molecular weights up to about 600. A system for introducing heated samples was so arranged that the sample could be measured as a liquid volume and so that there would be complete vaporization of hydrocarbons up to a molecular weight corresponding to C_{30}. Mass spectra are presented for several types of hydrocarbons between C_{14} and C_{28}. Some preliminary relationships are given between the spectra and molecular structure. The results of the work indicate that by extension of data of this type, the technique may prove useful in the analysis of petroleum fractions boiling above the gasoline range. As a typical example, the analysis of a petroleum wax is given as this was determined by the mass spectrometer. Detection of impurities in supposedly pure compounds is shown for several heavy hydrocarbons. Data are presented in considerable detail in tabular and graphical form and a bibliography of 18 references is included.

Shell Research Chemists Get Refinery Assignments

Shell Development research chemists have taken temporary assignments at Shell Oil refineries to obtain broader experience with refinery operating problems.

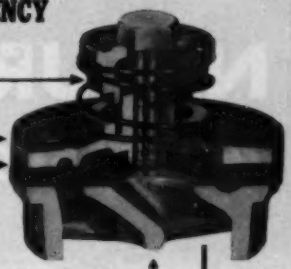
J. H. Raley has been assigned to the Houston refinery for a two-year period to study reaction kinetics. J. W. Otvos, who has been using isotopes to investigate reaction mechanisms, and G. E. A. Wyld, analytical chemist, will go to the Wood River refinery. Otvos' assignment is for two years, and Wyld's is for approximately one year. In exchange, K. Kressler of the Wood River control laboratory staff will join the Shell Development analytical staff.

Synthetic Rubber Proves Costly in Production

P. W. Litchfield, chairman of the board of Goodyear Tire & Rubber Company, has suggested that new petroleum-base plants with a total capacity of 220,000 tons of GRS, replace alcohol-base synthetic rubber plants. The manufacturing cost of GRS synthetic rubber produced from alcohol-base plants is 25 cents per pound greater than the same product manufactured from petroleum-base plants.

Terming the alcohol base production "uneconomic" he stated that such plants can prove of value only in time of great emergency.

4 WAYS TO REDUCE PUMP REPAIRS AND GAIN INCREASED EFFICIENCY



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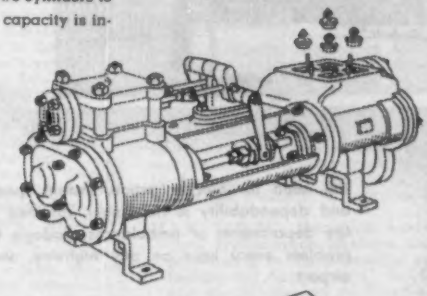

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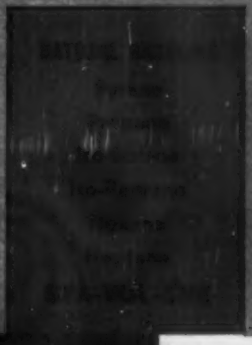

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Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, August 14, 21, 28 and September 4 and 11, 1951)

REFINING

U.S.P. 2,564,071. Refining Oils. A. P. Lien, B. L. Evering, and F. W. Haeckl to Standard Oil Co. of Indiana.

Details are claimed of a process for refining a hydrocarbon lubricating oil stock having a specific dispersion in excess of 100 by means of liquid HF at a temperature of 200° F. and thereafter with liquid HF-BF3 at 40-80° F.

U.S.P. 2 564,278. Selective Conversion of Alkyne Hydrocarbons. G. C. Ray to Phillips Petroleum Company.

Olefinic hydrocarbons containing minor amounts of an alkyne, such as acetylene, are contacted with 1-15 mols of steam per mol of alkyne at a temperature of 230-350° C. in the presence of a copper pyrophosphate catalyst on a solid carrier. Alkyne-free olefins are recovered.

U.S.P. 2,564,405. Process for the Purification of 4-Methylpentadiene-1,3. R. C. Morris and A. V. Snider to Shell Development Company.

A process is described for the separation of 4-methylpentadiene-1,3 from a mixture with 2-methylpentadiene-1,3. The mixture is contacted with an alpha hydrocarbon substituted alpha-beta-unsaturated aldehyde such as methacrolein at below 150° C. and unreacted 4-methylpentadiene-1,3 is separated from the reaction mixture.

U.S.P. 2,564,504. Liquid Burning Fuel. George H. Rieke.

A gasoline is claimed which contains 0.05 to 2 percent by weight of a 30 percent to 60 percent hydrogenated phenyl compound. The additive incorporates anti-knock properties to the gasoline and is stable to decomposition.

U.S.P. 2,564,532. Separation of Naphthene Hydrocarbons. A. E. Hirschler to Sun Oil Company.

Two naphthene hydrocarbons are separated by introducing their liquid mixture which is essentially free of unsaturates into a body of activated carbon; one of the naphthenes is selectively adsorbed.

U.S.P. 2,564,717. Continuous Adsorption Process. J. L. Olsen to Sun Oil Company.

Details are claimed of a continuous process for separating aromatic and saturated hydrocarbons by means of a continuous moving bed of a particular adsorbent such as silica gel or activated carbon.

U.S.P. 2,564,914. Method of Separating Unsaturated Hydrocarbons by Means of Hypochlorous Acid. M. J. Murray to Universal Oil Products Company.

Cyclic, tertiary and secondary olefins are removed from a hydrocarbon mixture also containing 1-olefins by treatment at 0-30°C, with an aqueous solution of hydrochlorous acid in sufficient quantity to react with the olefins other than 1-olefins. Superatmospheric pressure may be employed.

U.S.P. 2,564,970. Liquid-Liquid Contacting. G. H. Hanson to Phillips Petroleum Company.

The method is claimed of carrying out continuous countercurrent liquid-liquid extraction in a vertical column having horizontal trays therein and arranged to allow solvent to flow downwardly in intimate countercurrent relationship with ascending feed and raffinate phase and to allow separation and maintenance of two separate liquid phases between adjacent trays, which comprises continuously introducing a selective solvent into the top of said column and causing same to descend therethrough in intimate countercurrent relationship with ascending feed and raffinate phase, continuously withdrawing extract phase from the bottom of said column, continuously introducing feed to said column at a point therein well below the top of the column and causing same to ascend therethrough, continuously withdrawing raffinate phase from the top of said column, continuously withdrawing raffinate phase from a plurality of points in said column and re-introducing each of the withdrawals into said column at points a plurality of trays below the points of withdrawal thereof, and continuously withdrawing extract phase from a plurality of points in said column and re-introducing each of the withdrawals into said column at points a plurality of trays above the points of withdrawal thereof, said points of withdrawing and re-introducing raffinate phase being so spaced from each other and said points of withdrawing and re-introducing extract phase being so spaced from each other that less than one equilibrium stage would occur therebetween in the absence of said withdrawing and re-introducing of phases.

U.S.P. 2,565,354. Chemical Process for Removal of Organic Peroxides. Charles A. Cohen to Standard Oil Development Company.

Peroxides contained in hydrocarbons and oxygen contaminants contained in olefins susceptible to the formation of peroxides are removed by contact in the fluid state with an aqueous reagent consisting of sodium hydrosulfite and a leuco base of a water soluble dye stuff.

U.S.P. 2,566,135. Method of Removing Acetylenes from Diolefin Mixtures. C. E. Morrell and M. W. Swaney to Standard Oil Development Company.

To concentrate a diolefin with 4-6 C atoms, e.g. butadiene, a basic cuprous salt solution having the diolefin and small amounts of acetylenic impurities absorbed therein is heated to a temperature of 70-85° C. to desorb the diolefins. The remaining lean solution is exposed to conditions causing polymerization of acetylene.

U.S.P. 2 566,136. Method of Removing Acetylenes from Diolefin Mixtures. C. E. Morrell to Standard Oil Development Company.

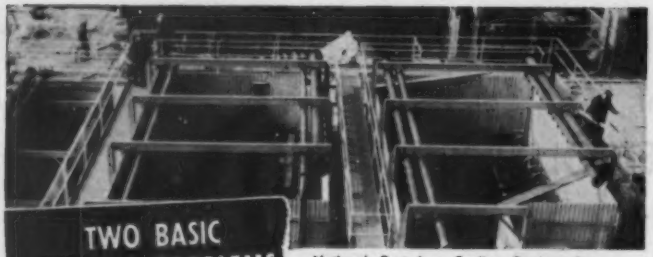
The method according to this patent is very closely related to that of U.S.P. 2,566,135. In the present case the polymerization of the acetylenes contained in the cuprous salt solution is carried out in the presence of hydrocarbons.

U.S.P. 2,566,137. Removing Acetylenes from Hydrocarbon Mixtures and Improvements in the Separation of Butadiene and Acetylenes. C. E. Morrell and M. W. Swaney to Standard Oil Development Company.

The process according to this patent is very closely related to U.S.P. 2,566,135-6. In the present case the polymer of acetylenes formed in the cuprous salt solution is extracted therefrom by an oxygenated organic solvent immiscible with said salt solution.

U.S.P. 2,565,347. Stabilization of Pyrophoric Metal Catalysts under Fluidized Conditions. J. G. M. Bremner and and Stanley Beaumont to Imperial Chemical Industries, Ltd.

A heavy metal compound in particulate form is reduced with a mixture of hydrogen and an inert gas. The reduced metal is cooled to below 60° C. by a stream of inert gas and thereafter superficially oxidized below 60° C. by a mixture of oxygen and inert gas. During all



National Cast Iron Cooling Sections for compressor and engine jacket water at the Glenwood Landing Plant of Long Island Lighting Company.

TWO BASIC COOLING PROBLEMS *solved*

FOR THE LONG ISLAND LIGHTING COMPANY WITH

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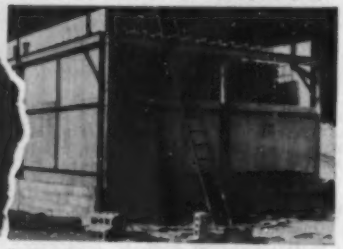

Cooler of three double banks of National Sections for scrubbing liquor at the Glenwood Landing Plant of Long Island Lighting Company.

National Cooling Sections installed at the new gas conversion plant of the Long Island Lighting Company at Glenwood Landing, are (1) cooling the recirculating scrubbing liquor which cleans and cools finished gas in the reforming process, and (2) cooling the fresh water that is circulated in the jackets of gas compressors.

Over 28,000 square feet of cooling surface is provided by these National Sections built up in banks of parallel stacks of sections in series—1254 sections in the scrubbing cooler and 1280 sections in five compressor coolers.

In this plant the National Sections operate as a closed cooling system—fresh water being circulated through the sections with raw salt water from Hempstead Harbor sprayed over the section exteriors—thus prolonging the life of the equipment because corrosive salt water is not in contact with operating machinery. National Cooling Sections are made of highest grade cast iron, have high resistance to salt water corrosion and are economical both in first cost and maintenance.

The installation has proved so satisfactory that additional National Sections have been purchased by the Long Island Lighting Company for new construction.

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these steps the particles are supported in fluidized state in the inert gas.

U.S.P. 2,565,627. Coprecipitated Silica-Magnesia Gel. J. N. Pryor to The Davison Chemical Corporation.

In the preparation of a magnesia-silica catalyst, MgO is mixed with an alkali metal silicate solution. The resulting slurry is mixed with an inorganic acid, e.g. H_2SO_4, to form a magnesia silica hydrosol which is gelled. The gel is washed, dried, and activated.

U.S.P. 2,565,886. Preparation of Silica-Alumina Cracking Catalyst. L. B. Ryland to Shell Development Company.

For preparing a silica sol containing at least 85 grams SiO_2 per liter, a sodium silicate solution is mixed with H_2SO_4 solution under acid conditions with a final pH of 2.8-4.1. This sol is aged at the same pH range for a time which is at least 0.5 but less than one times the time of set of the sol. At this time the sol is diluted with water with maintenance of about constant viscosity. The pH is then increased up to seven by the addition of alkali while adding water to maintain the viscosity constant. A conc. aluminum sulfate solution is then added in an amount to provide 18-30 percent Al_2O_3 on dry basis. The aluminum sulfate is hydrolyzed by addition of a basic precipitant until the pH is 5-7, whereupon the product is washed and dried.

U.S. P. 2,565,977. Process for the Preparation of Catalysts for the Conversion of Carbon Oxides with Hydrogen. D. R. McAdams and M. A. Segura to Standard Oil Development Company.

Iron type catalysts for the Fischer-Tropsch synthesis are prepared by mixing sintered iron pyrites ashes with a proportion, e.g. 2-8 percent, of carbon, treating the mixture with oxygen-containing gas under conditions for combusting the carbon, and subjecting the resulting resintered iron oxide to reduction by hydrogen gas.

U.S.P. 2,566,285. Method for Regeneration of Moving Catalysts. L. P. Evans and W. A. Hagerbaumer to Socony-Vacuum Oil Company, Inc.

Spent hydrocarbon conversion catalyst is regenerated by combustion of carbonaceous deposits in a method details of which are claimed.

U.S.P. 2,566,521. Alumina-Platinum Oxysulfide-Halogen Catalyst and Its Preparation. V. Haensel to Universal Oil Products Company.

A hydrocarbon conversion catalyst is prepared by combining with alumina halogen in an amount of 0.1-8 percent by weight of the alumina on a dry basis. A platinum sulfide is composited therewith, and the composite is subjected to an oxidation treatment and subsequently heated to 800-1200° F.

U.S.P. 2,567,140. Preparation of an Iron Oxide-Magnesium Chromate Catalyst. K. D. Ashley and W. B. Innes to American Cyanamid Company.

An iron oxide-magnesia catalyst of high activity and mechanical strength, useful in the water gas process, is obtained by preparing a mixture of Fe_3O_4, 10-100 percent of "active magnesia" based on the weight of the Fe_3O_4, 3-40

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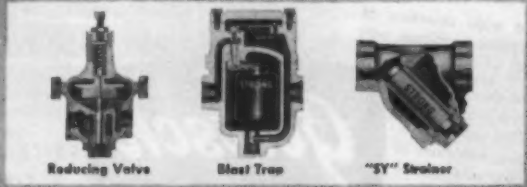

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percent of magnesium chromate, and sufficient water to hydrate all of the magnesia. The mixture is compressed into pellets which are then aged while retaining their water to form therein a set hydraulic cement. Subsequently the pellets are dehydrated by calcining them at 500-650° C.

CRACKING AND REFORMING

U.S.P. 2,564,268. Catalytic Oil Cracking. E. V. Mathy and C. J. Helmers to Phillips Petroleum Company.

Activated bauxite is employed as a cracking catalyst which contains impregnated on its suface 0.1-10 percent of boron trioxide and 0.1-10 percent by weight of P_2O_5.

ISOMERIZATION

U.S.P. 2,564,073. Disproportionation of Xylenes. A. P. Lien and D. A. McCauley to Standard Oil Company of Indiana.

A xylene is treated in the absence of any external benzene with 3-20 moles of liquid HF per mole of xylene and 0.01-3 moles BF_3 per mole of xylene at 250-350° F. and sufficient pressure to maintain liquid phase. The xylene is isomerized and disproportionated into toluene and mesitylene. The reaction mixture is extracted with a molar excess of liquid HF containing 0.2-0.8 moles BF_3 per mol of hydrocarbon at 0-150° F. in liquid phase. The hydrocarbon layer is enriched in o- and p-xylene and toluene, while m-xylene and mesitylene are in the HF-BF_3 phase.

U.S.P. 2,564,080. Isomerization of Saturated Hydrocarbons with Mixed Acid Cataclysts. A. K. Roebuck and B. L. Evering to Standard Oil Company of Indiana.

Alkyl-substituted and particularly mono-methyl or dimethyl substituted alkanes having a secondary C atom adjacent to a methyl substituted C-atom are isomerized in the presence of 0.5-2 parts by weight of 99-100 percent sulfuric acid and containing about 15 percent of a halogen sulfonic acid such as fluosulfonic or chlorosulfonic acids. Temperatures of 15-50° C. are employed and the feed hydrocarbon must contain at least six C atoms per mole.

U.S.P. 2,564,388. Isomerization of Xylenes. Clarence S. Bennett and W. A. Bailey, Jr., to Shell Development Company.

A xylene is contacted with a clay-type or synthetic cracking catalyst at 800-1100° F. in the presence of 0.2-6 moles of steam or hydrogen per mole of xylene. Isomerization occurs at space rates between 1-16V/V/hr. and above that affording substantial disproportionation.

U.S.P. 2,566,353. Purification of Oils. G. A. Mills to Houdry Process Corporation.

Hydrocarbon oils to be catalytically cracked and containing nitrogenous contaminants are contacted in liquid phase in the presence of water with an organic base-exchange resin to remove the nitrogenous contaminants.

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U.S.P. 2,566,613. Aromatic Recovery Process. H. J. Hepp to Phillips Petroleum Company.

Details are claimed of a continuous process for the extraction and recovery of aromatic hydrocarbon from a narrow boiling range stream of aromatic and paraffinic hydrocarbons wherein this stream is passed successively through each of three beds of adsorbent silica gel.

U.S.P. 2,566,979-980. Process of Breaking Water and Oil Emulsions. A. E. Catanach and R. P. Gulley to Gulf Oil Corporation.

In the breaking of stable oil-water emulsions containing a large proportion of inorganic salts, e.g. from hydrocarbon oil refineries, spent refinery caustic solution is added which has been pretreated by simultaneous steam and air blowing at a temperature of above 160° F. The resulting mixture is agitated and heated until the emulsion breaks. Instead of adding the pretreated caustic solution, the heated emulsion may be treated in any suitable way so that its water is adjusted to a pH of 11-13.

U.S.P. 2,567,057. Chemical Analysis Using Neutrons. K. C. Crumrine to The Texas Company.

A fixed fluid cross section of a mixture of carbon-hydrogen compounds is bombarded with neutrons the energy of which does not exceed 10^4 ev. The energy of the neutrons emerging from the mixture is then compared with a neutron intensity determined by bombarding a corresponding cross section of known carbonhydrogen composition with neutrons of corresponding energy.

U.S.P. 2,567,172. Method of Refining Oil with a Solvent. G. B. Arnold and W. E. Skelton to The Texas Company.

In a process for the solvent refining of kerosene and light gas oil wherein the difference between the initial true b.p. of the oil and the b.p. of the solvent is less than 75° F., a water-miscible organic solvent, such as furfural, is employed and extract and raffinate phases are formed. In subsequent treatment of the separated phases for recovery of solvent, oil capable of forming a ternary azeotrope and boiling between the b.p.'s of water and solvent is added.

U.S.P. 2,567,173. Process for Production of High Quality Petroleum Products. E. Arundale and L. A. Mikeska to Standard Oil Development Company.

Hydrocarbons boiling in the motor fuel range are contacted with a dilute aqueous mineral acid of 30-80 percent concentration, e.g. H_2SO_4, and containing 0.5-5 percent of an aldehyde, such as formaldehyde, based upon the hydrocarbon feed. Constituents tending to cause uncleanliness when burned in internal combustion engines are removed from the hydrocarbon feed by this treatment.

U.S.P. 2,567,174. Process for Improving Stability and Engine Cleanliness Characteristics of Petroleum Fractions. E. Arundale and J. P. Hanworth to Standard Oil Development Company.

The process of this patent is related to that of U.S.P. 2,567,173. Formaldehyde only is employed here at a temperature of 100-500° C. for the refining treatment of petroleum fractions or cracked petroleum boiling below 370° C.

U.S.P. 2,567,228. Extractive Distillation of Close-Boiling Hydrocarbon Fractions with Hydrotropic Solutions. C. E. Morrell, C. S. Carlson, J. F. Nelson, and J. Stewart to Standard Oil Development Company.

A mixture of close-boiling hydrocarbons of different degrees of polarizability is extractively distilled with the use as a solvent of an aqueous mixture containing at least 40 percent by weight of a salt containing at least one cyclic nucleus and having at least one water solubilizing group, such as a water-soluble salt of an aromatic sulfonic acid. The relative volatilities of the components of the hydrocarbon mixture are altered by this extraction solvent so that those which are rendered more volatile can be separated from those which are rendered less volatile.

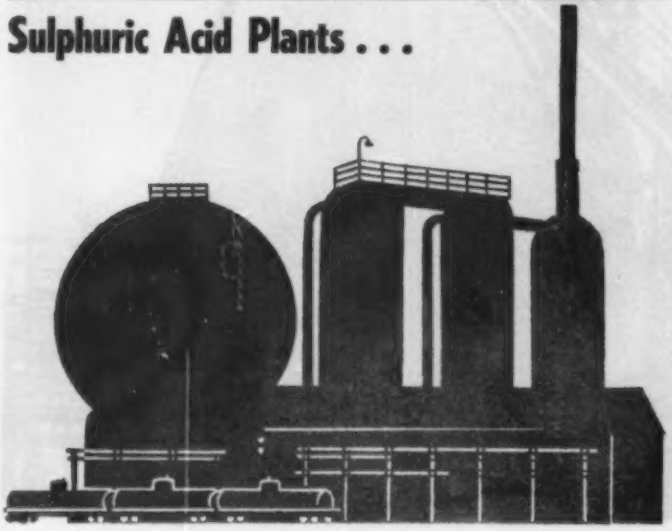
U.S.P. 2,567,252. Refining of Hydrocarbons. L. C. Strang to Anglo-Iranian Oil Company, Ltd.

Sulfur-containing hydrocarbon feed stocks are hydro-catalytically desulfurized in the presence of hydrogen without substantial cracking. Details of the process are claimed.

CATALYST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,563,977. Process for Continuously Acid Activating Clay. Lee Van

Sulphuric Acid Plants . . .



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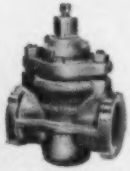

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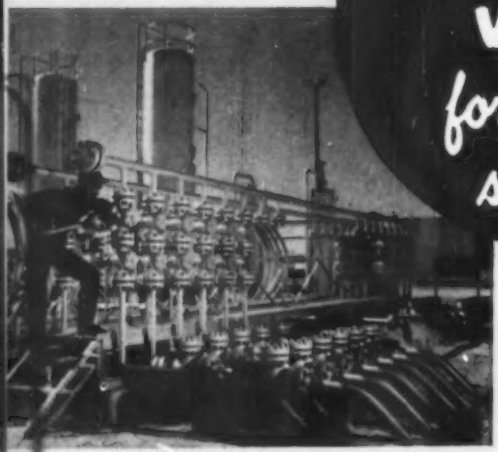

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Horn and L. A. Kahn to Filtrol Corporation.

Details are given of a process in which clay and acid are introduced to the top of a treating zone and withdrawn at the bottom and in which part of the acid is recycled in a side stream. Proportions of fresh and recycle acid and clay are specified.

U.S.P. 2,564,331. Preparation of a Coprecipitated Nickel-Zirconium Catalyst. H. K. Hawley to the Procter and Gamble Company.

Particularly active nickel catalysts promoted by zirconium are prepared by initially forming a water soluble carbonate complex of the promoter metal in an aqueous solution which contains a sufficient excess of carbonate radicals to form the carbonate of the subsequently added nickel as well as the carbonate of the already present promoter metal. The amount of carbonate employed is sufficient to give the final slurry of pH of at least 8.2.

U.S.P. 2,564,776. Extrusion of a Frozen and Thawed Hydrogel. E. A. Bodkin and J. W. Payne to Socony-Vacuum Oil Company, Inc.

Hard granules of an inorganic oxide gel comprising at least a major portion of silica and possibly a minor portion of hydrous inorganic metal oxide (alumina) and having incorporated a small amount of zeolitic alkali metal are prepared by coprecipitation and freezing of the hydrogel at about 0° F. The frozen gel is thawed and shrunken granules and an aqueous liquid are separated. The granules are extruded through a die and dried.

ALKYLATION

U.S.P. 2,563,826. Process for Producing 3,5-Dimethyl 1-Ethyl Benzene. W. E. Elwell and A. J. Castro to California Research Corporation.

Ethylene and pure meta xylene are contacted in the presence of less than two mole percent $AlCl_3$ based on xylene at 45-95° C. for 0.5-18 hours. 3,5-dimethyl, 1-ethyl benzene substantially free of 2,5-dimethyl 1-ethyl benzene is obtained .

U.S.P. 2,564,072. Alkylation Process. A. P. Lien and J. F. Dieters to Standard Oil Company of Indiana.

Olefinic hydrocarbon fractions having 10-15 C atoms and comprising oil soluble, neutral oxygen containing organic compounds, such as olefins obtained in a hydrocarbon synthesis process, are alkylated with benzene or toluene in the presence of HF. The alkylation is carried out in such a manner that contact of the olefins with HF in the absence of the aromatic hydrocarbon is avoided. A separation of oxygen containing olefins from hydrocarbons is accomplished and valuable alkymers uncontaminated by oxygen compounds are obtained.

U.S.P. 2,564,077. Alkenylation Process. Wayne A. Proell to Standard Oil Company of Indiana.

Aromatics of the benzene and naphthalene series are alkenylated with a conjugated diolefin with not more than six C atoms per mole at 0-150° C. in the presence of .5-50 weight percent of an alkane-sulfonic acid having at most five C atoms per mole, such as ethanesulfonic acid. Benzene and butadiene give 1-phenyl-butene-2.

U.S.P. 2,564,488. Alkylation of Toluene by Propylene Catalysed by Acid Activated Montmorillonite Clay. John E. Mahan to Phillips Petroleum Company.

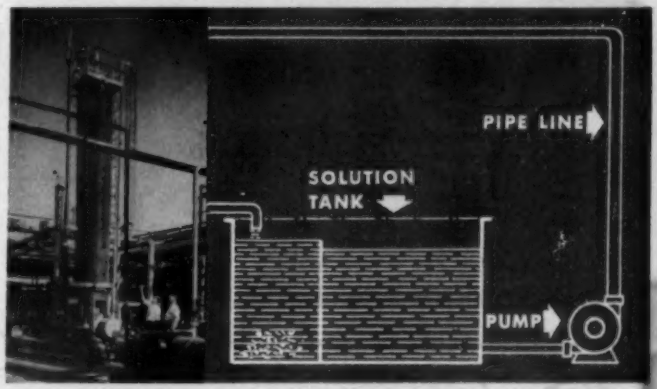
Toluene is alkylated with an olefin such as propylene at 375-700° F. and elevated pressure such as 1000 psi. in the presence of acid activated montmorillonite sub-bentonite catalyst. Meta- and Para-substituted alkylated toluene is obtained with only minor proportions of ortho-substituted product.

POLYMERIZATION AND CONVERSION

U.S.P. 2,563,997. Styrene-Butadiene Copolymer and Process of Preparing Same. W. E. Elwell and R. L. Meier to California Research Corporation.

An organic solution of 1,3-butadiene and 5-95 percent by weight of a styrene containing a single vinyl group is copolymerized by passing gaseous BF_3 therethrough at a temperature of 0-60° C. The reaction is interrupted not later than the instant of formation of a copolymer gel. The copolymer recovered from the solvent is at least partly soluble in chloroform. Halogenated hydrocarbons can be employed as the organic solvent in the reaction.

U.S.P. 2,564,632. Emulsion Polymeriza-



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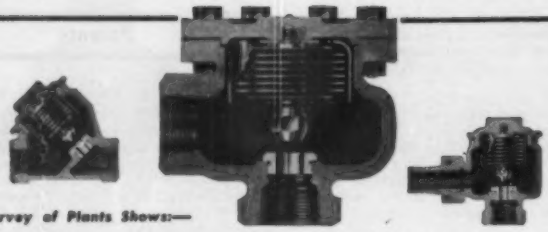

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Patents

tion with Pentazdienes. J. E. Wicklatz to Phillips Petroleum Company.

A major amount of a 1,3-diolefin, such as 1,3-butadiene, and a minor amount of a vinyl compound, such as styrene, are emulsion copolymerized in the presence of 0.2-6 percent of a 1,5-diaryl-1,4-pentazdiene as a reaction iniator. Synthetic rubber is obtained. The said unsaturated types of monomers can also be polymerized separately by means of this iniator.

U.S.P. 2,564,736. Process of Producing Carbon Black. C. A. Stockes to Godfrey L. Cabot, Inc.

Natural or other hydrocarbon gas is continuously delivered to an unobstructed combustion space in rows of small jets. Each row is enveloped in a stream of nitrogen-free recycle gas in a stream of pure oxygen. The reaction temperature is maintained by partial combustion of the enveloping gas mixture. Carbon black and the recycle gas are produced.

U.S.P. 2,564,833. Sulfur Dioxide Process and Apparatus Using Recycled Gases. R. T. Collier to Union Oil Company of California.

A liquid hydrocarbon containing material is decomposed under such conditions of temperature and pressure that solid carbon particles and gaseous products are formed. The gaseous products are recycled at least in part at raised temperature and pressure for atomizing the charge material to be decomposed.

U.S.P. 2,565,395. Production of Hydro-

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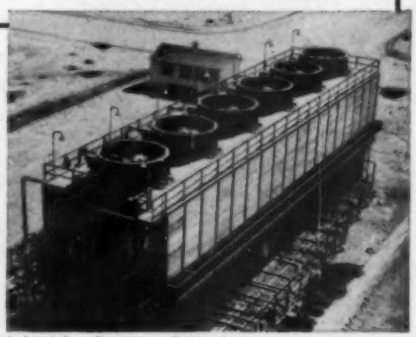
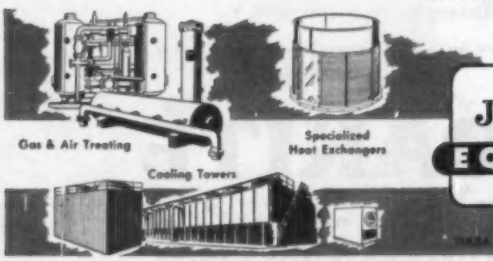


Industrial cooling tower designed, engineered and constructed by J. F. Pritchard & Co.



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Patents

gen from Hydrocarbon Gases. W. G. Scharmann to Standard Oil Development Company.

A hydrocarbon feed containing olefins is passed together with a mild oxidizing gas at conversion temperature over a plurality of Group VIII metal catalyst layers. The activity of these layers for the conversion of saturated and the cracking of unsaturated hydrocarbons shall increase in the direction of the flow of the feed. While passing the feed over the first layer, a temperature of 900-1600° F. is maintained to convert the olefins completely into hydrogen and carbon oxide under suitable conditions of velocity and time, so that contact of such olefins with subsequent layers of catalyst is prevented.

U.S.P. 2,565,398. Production of Oxidation Resistant High Molecular Weight Pentadiene Copolymers. H. G. Schutze to Standard Oil Development Company.

A feed mixture of a major amount of tertiary mono-olefin, such as isobutylene, and a minor amount of 4-methyl-1, 3-pentadiene is chilled to a temperature of —120° to —175° F. and then contacted with a chilled solution of $AlCl_3$ in an alkyl halide having a concentration of .05-0.5 percent by weight of $AlCl_3$ and a ratio of $HAlCl_4$ to $AlCl_3$ in the range from 0.5 to 5:100. A rubbery polymer is formed.

U.S.P. 2,565,498. Hydrocarbon Conversion. R. W. Harkness to Houdry Process Corporation.

In hydrocarbon conversion in the presence of a refractory catalytic contact mass, the hydrocarbonaceous deposit accumulating on the contact mass is at least partially decomposed in an atmosphere unreactive with this deposit at an elevated temperature below the deactivation temperature of the contact mass. The hydrocarbons are subsequently contacted under conversion conditions with a refractory catalytic mass which consists at least in part of catalytic mass comprising substantially all of the deposit remaining thereon after the thermal decomposition. The activity of the catalytic mass is restored to a relatively high level by the thermal treatment.

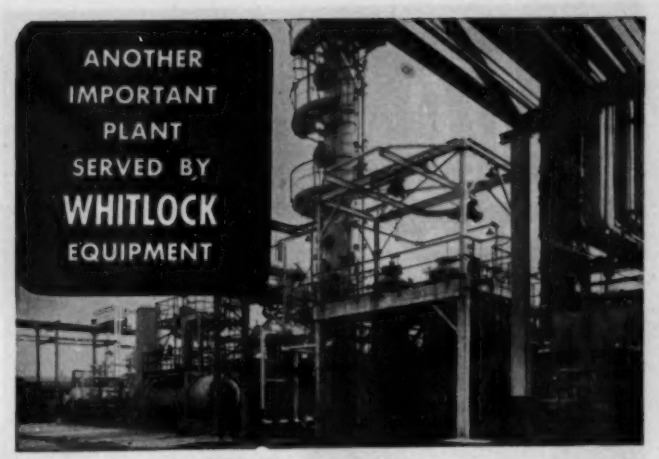
U.S.P. 2,565,960. Preparation of an Improved Hydrocarbon Resin. J. D. Garber and D. W. Young to Standard Oil Development Company.

Details are claimed of a process for production of a clear, light colored resin or resin solution by copolymerization of butadiene with diisobutylene at low temperature in the presence of a Friedel-Crafts catalyst.

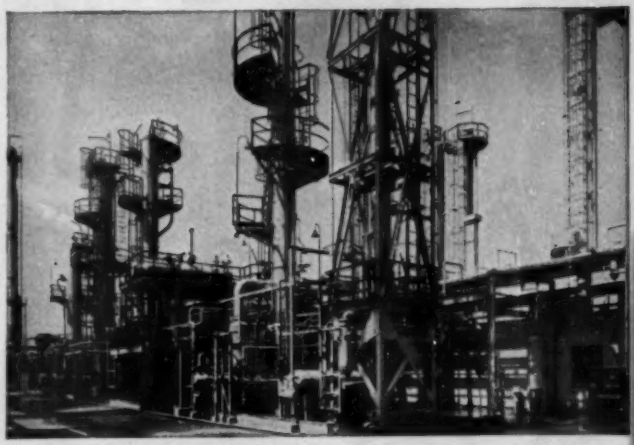
U.S.P. 2,566,159. Process and Apparatus for Effecting Chemical Reactions with Solid Catalyst Particles. L. V. H. Beckberger to Sinclair Refining Co.

In the pyrolytic conversion of hydrocarbons, the feed material is passed in vapor phase in contact with a vertically disposed non-fluidized spiral bed of catalyst particles which is moved vertically upwards. The flow of gaseous liquid through the spiral space above the catalyst bed is completely blocked at periodic intervals and the blocked gaseous fluid is directed downwardly into the spiral bed.

U.S.P. 2,566,251. Homogenous Copolymers of Aliphatic Conjugated Diolefin



Shell Chemical Corporation Plant, Houston, Texas



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Patents

Hydrocarbons with Polymerizable Vinyl Carboxylates. L. M. Richards to E. I. du Pont de Nemours & Company.

Homogeneous copolymers of a monomeric aliphatic conjugated diolefin of not more than 6 C atoms, e.g. butadiene-1,3 with a polymerizable vinyl ester of a saturated monocarboxylic acid of less than five C atoms, such as vinyl acetate, are prepared by a process claimed in detail.

U.S.P. 2,566,537. Peroxide Catalyzed Polymerization of Ethylene in the Presence of a Phenolic Compound. L. Schmerling to Universal Oil Products Company.

In the polymerization of ethlyene in the presence of an organic peroxide catalyst and an organic diluent of special type, a phenolic compound, such as a monohydric phenol or an alkylphenol, is added in an amount sufficient to increase the m.p. of the ethylene polymer.

U.S.P. 2,566,538. Peroxide Catalyzed Polymerization of Ethylene in the Presence of an Amino Compound. L. Schmerling to Universal Oil Products Company.

The process according to this patent differs from that of U.S.P. 2,566,537 essentially only in that instead of the phenolic compound an aniline compound substituted in the p-position by hydroxyl or an amino radical is employed.

U.S.P. 2,566,821. Polymerization of Butadiene-1,3 Hydrocarbons in Aqueous Emulsion in the Presence of a Ferricyanide, a Diazomercapto Compound, and an Alcohol. H. P. Brown and R. J. Houston to The B. F. Goodrich Company.

A monomeric material comprising a butadiene-1,3 hydrocarbon is emulsion polymerized at a temperature of 10-100° C. and in the presence of (1) a diazomercapto compound of the formula Ar—N=N—S—R wherein Ar is a monovalent aromatic radical having its connecting valence on a nuclear C atom and R is a monovalent organic radical of a certain type, such as a naphthyl group, (2) a liquid water-miscible aliphatic alcohol in an amount of 1-25 percent by weight of the total monomeric material, and (3) a water-soluble ferricyanide.

U.S.P. 2,566,896. Method of Sealing Hydrocarbon Conversion Housings. L. J. Kelly to Houdry Process Corporation.

In a hydrocarbon conversion system in which solid contact material is passed cyclically through separate zones and is contacted therein with different gases under different pressures, the contact material is transferred between these zones while a gas seal is maintained therebetween. Details of this method are claimed.

U.S.P. 2,567,137. Interpolymerization of Styrene and Frosting Drying Oil in Presence of Monocyclic Alpha-Terpene. L. E. Wakeford and D. H. Hewitt to The Sherwin-Williams Company.

Styrene and an unpolymerized frosting drying oil are heated in the presence of a solvent comprising an amount of a monocyclic alpha-terpene sufficient to prevent gelation during the interpolymerization and to prevent frosting of

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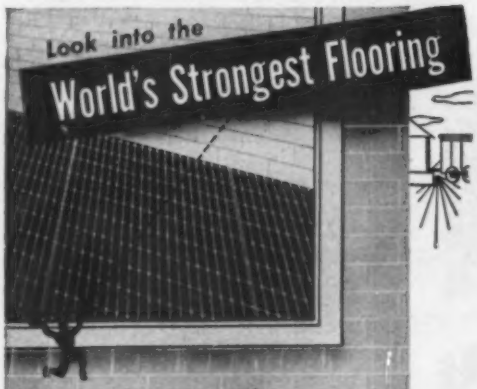

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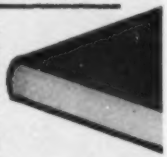

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By LESTER CHARLES UREN
Professor of Petroleum Engineering, University of California

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films of the product on drying. No catalyst is required in this interpolymerization.

U.S.P. 2,567,207. Maintenance of Catalytic Activity in Hydrocarbon Conversion Systems. A. W. Hoge to Houdry Process Corporation.

In a process for the conversion of hydrocarbons in the presence of a downwardly moving non-turbulent bed of catalyst graduated in size, with subsequent regeneration of spent catalyst by an oxygen-containing gas, the catalyst particles are heated during regeneration to a temperature substantially above that in the conversion zone. A portion of the hot catalyst particles is contacted with a stream of cool oxygen-containing gas to preheat the latter. The thus cooled catalyst particles are treated to separate them into a less catalytically active fraction of particles of higher apparent density and a more active fraction of lower particle density. The latter are mixed with hot particles of regenerated catalyst whereupon the resulting mixture is recycled to the conversion zone.

U.S.P. 2,567,283. Method of Manufacturing Motor Fuels by Polymerization and Alkylation. A. R. Goldsby to The Texas Company.

A hydrocarbon mixture containing normally gaseous olefins of different molecular weights, such as propylene and butylene, is treated to polymerize the olefins of one molecular weight without poylmerizing those of a different molecular weight. The unpolymerized olefins are then separately polymerized. The separated various polymers are separately alkylated with an isoparaffin in the presence of a catalyst at different optimum temperatures.

DESULFURIZATION

U.S.P. 2,565,349. Method for Sweetening Petroleum Distillates. John G. Browder and A. R. Smith to Standard Oil Development Company.

Sour distillates boiling below 750°F. are sweetened by treatment with an alkali metal hydroxide solution (0.1-5 percent of the hydrocarbons) containing pyridine (0.1-5 percent of the hydrocarbons) in the presence of a mild oxidizing agent such as air.

U.S.P. 2,567,175. Desulfurization and Sweetening of Virgin Distillates with an Aldehyde. E. Arundale and E. E. Juterbock to Standard Oil Development Company.

The process of this patent is related to that of U.S.P. 2,567,173. A reagent consisting of 0.05-0.5 percent of formaldehyde or acetaldehyde (based on the weight of the oil to be treated) and H_2SO_4 is employed here for the removal of sulfur compounds from virgin naphtha, or virgin petroleum oils boiling below 700°F., or virgin distillates boiling in the motor fuel range. An amount of H_2SO_4 is used such that the concentration of the acid in the aqueous phase of the mixture is in the range of 50-88 percent.

HEAVY OILS AND WAXES

U.S.P. 2,564,422-3. Corrosion Preventive Composition. E. R. Barnum to Shell Development Company.

A corrosion inhibiting composition comprises a major amount of a liquid hydrocarbon and a minor amount of 0.5-10 percent dispersed therein, of pentaerythritol dioleate, sorbitan mono-oleate, or glycerol mono-oleate. A salt of a cycloalkyl amine and an aliphatic carboxylic acid with at least eight C atoms are added to dissolve the partial ester additive. Instead of this solvent a salt of oxazoline, isoxazoline, oxazolidine, or isoxazole and a petroleum sulfonic acid or an unsaturated aliphatic monocarboyxlic acid with 18 C atoms may be employed.

U.S.P. 2,564,561. Grease Composition. E. S. Carmichael and E. L. Armstrong to Socony-Vacuum Oil Company, Inc.

Lubricating oil is compounded with a sufficient proportion of fatty acid barium soaps to form a barium base grease. A small proportion of the barium salt of a monobasic fatty acid with not more than six C atoms is added for stabilizing the grease.

U.S.P. 2,564,634. Lubricant Containing Hydroabietyl Esters. L. C. Beard, Jr., and R. V. White to Socony-Vacuum Oil Company, Inc.

A base oil of petroleum origin is compounded with 0.1-10 percent by weight of a mixture of (1) a half ester of malic acid and hydroabietyl alcohol and (2) a half ester of malic acid and an aliphatic monohydric alcohol having 8-20 C atoms. The lubricant compound

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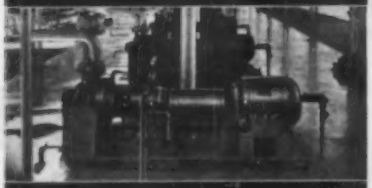

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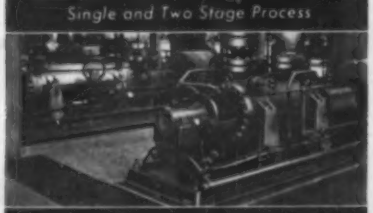

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U.S.P. 2,565,403. Textile Oils. L. W. Sproule and T. W. Dixon to Standard Oil Development Company.

A textile oil composition consists of 76-94.4 percent by weight of a mineral base oil of 50-200 S.S.U. viscosity at 100°F., 5-20 percent of oil soluble alkali metal sulfonate of a mole wt. of 380-480, 0.5-2.5 percent of a polyoxyalkylene derivative of sorbitan mono-oleate, and 0.5-1.5 percent of sorbitan mono-oleate.

U.S.P. 2,565,489. Process of Dewaxing of Mineral and Tar Oils. K. A. Fischer, Washington, D. C.

In the dewaxing of mineral oil and the like by the combined use of a selective and non-selective solvent and subsequent chilling of the solution formed, the ratio of selective solvent to the remaining components is progressively reduced during the chilling substantially proportional to the rate of progress of the chilling.

U.S.P. 2,565,981. Production of Lubricating Grease. A. J. Morway, H. L. Leland, and G. W. Duncan to Standard Oil Development Company.

A lubricating grease is prepared from a hydrocarbon lubricating oil, 0.1-8 percent by weight of a C_7-C_4 aliphatic alcohol ester of a low molecular weight monocarboxylic acid, 5-30 percent of a saponifiable fatty material and a saponifying agent under conditions claimed in detail.

U.S.P. 2,566 289. Lubricants for Steam Turbines. R. G. Mastin to Cities Service Oil Company.

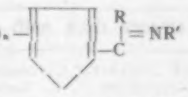
A major proportion of a mineral lubricating oil is compounded with a minor proportion (e.g. 0.1-1.0 percent) of p-methoxy-benzyl-m-toluidine to inhibit oxidation of the oil over long periods of time.

U.S.P. 2,566,397-8. Lubricants and Lubricant Additives. J. D. Bartleson and H. P. Lankelma to The Standard Oil Company (Ohio).

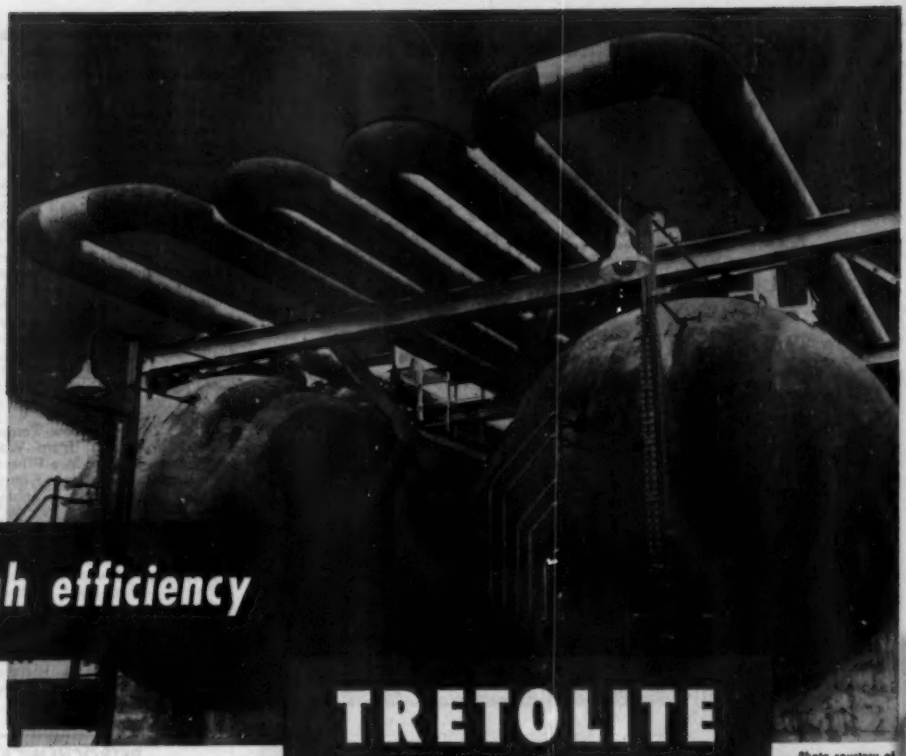
A mineral lubricating oil is compounded with a minor amount of an oil-dispersable product of the reaction at 350°F. for eight hours of 1.15 moles ethyl mercaptan to each mole of a reaction product of one mole P_2S_5 and 1.5 moles of "reduced motor polymer", such as octene-1. The additive inhibits oxidative deterioration of the oil in use. Instead of the ethyl mercaptan a corresponding amount of ethyl alcohol may be used.

U.S.P. 2,566,611. Mineral Oil Composition Containing an Alkyl Thienyl Ketimine. H. D. Hartough to Socony-Vacuum Oil Company Inc.

A major proportion of mineral oil is mixed with less than ten percent by weight of a compound of the general formula



where R is an alkyl group of 1-17 C atoms, R′ is an aryl or alkyl radical of at



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lease five C atoms, R" is a hydrogen, halogen, amino, nitro, or alkyl group, and n is an integer of 1-3. The additive stabilizes the oil against oxidation.

U.S.P. 2,566,793. Grease Compositions. R. G. Davies and R. W. Noad to Shell Development Company.

A lubricating grease comprises a major proportion of a mineral oil and minor amounts of a mixture of lithium soap of a high molecular weight hydroxy fatty acid and non-lithium alkali metal soap of high molecular weight fatty acids. The ratio of the Li soap to the non-Li soap may vary from 90:10 to 95:5 and the hydroxyl content of the entire soap mixture from 3.2 to 4.0 percent.

U.S.P. 2,567,646. Low-Temperature Separation of Oil from Wax Involving Initial Chilling in a Film-Chiller. J. L. Little to The Texas Company.

In the dewaxing of lubricating oil or the like with recovery of crystallined wax, the cooled oil wax feed is contacted with a passing chilled metallic surface. Solidified oil and wax are deposited on this surface in a thin layer. The solidified layer is discharged from the removed surface at a dewaxing temperature of 0° F. and below and is then mixed with cool dewaxing solvent in amounts sufficient to dissolve oil constituents thereof and form a filtrable mixture for removing the wax from the oil.

PETROCHEMICALS

U.S.P. 2,564,130. One-Step Butyl Alcohol Process. R. C. Schreyer to E. I. du Pont de Nemours & Company.

Propylene is reacted with CO and H_2 under superatmospheric pressure at a temperature of 225-300°C. in the presence of water and a cobalt-containing catalyst. The reaction product containing n-butanol, isobutanol, and butyl formate is treated to recover the butyl formate which is recycled to the reaction vessel whereupon n-butanol and isobutanol are recovered from the reaction mixture.

U.S.P. 2,565,087. Process for Oxidation of Cycloaliphatic Compounds. F. Porter and J. N. Cosby to Allied Chemical & Dye Corporation.

Cyclohexane and methylcyclohexane are partially oxidized in the liquid phase by an oxygen-containing gas in the presence of 10-30 percent added water. The oxidation is stopped at a conversion not greater than 15 percent. A water phase and an oil phase are formed. The aliphatic alcohol of the charge hydrocarbon is formed and the formation of ester by-products is substantially reduced.

U.S.P. 2,565,215. Preparation of Carbon Disulfide. H. O. Folkins and E. L. Miller to The Pure Oil Company.

A mixture of sulfur and hydrocarbon gas rich in methane is contacted at a temperature of 575-700°C. with a synthetic silica-alumina catalyst consisting essentially of 2-10 percent by weight of silica and the balance alumina. CS_2 and H_2S are formed.

U.S.P. 2,565,493. Method for the Preparation of Sulfurized Paraffins. R. H. Gardner to Sinclair Refining Company.

A sulfur chloride is reacted with about a molar proportion to a substantial excess of paraffinic hydrocarbon containing a tertiary C atom, such as isooctane, in the presence of at least 0.1 mol of admixed anhydrous $AlCl_3$.

U.S.P. 2,566,052. Process for Photochemical Chlorination of Hydrocarbons. W. S. Beanblossom to the U. S. Atomic Energy Commission.

A paraffin of 5-10 C atoms, e.g. heptane, is treated in the liquid phase with elemental chlorine diluted with HCl under actinic light. The resulting partially chlorinated mixture is reacted in the liquid phase with undiluted chlorine under actinic light until the exit gas contains a substantial amount of elemental chlorine. This exit chlorine is employed during the initial stage of the process.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,564,606. Hydrocarbon Synthesis. P. C. Keith and E. W. Riblett to Hydrocarbon Research Inc.

In a Fischer-Tropsch synthesis employing an iron group catalyst promoted by alkali metal in a fluidized dense phase, the alkali metal content of the catalyst is periodically supplemented to maintain the selectivity of the catalyst for the production of normally liquid hydrocarbons.

U.S.P. 2,564,958. Fischer-Tropsch Process for the Synthesis of Hydrocarbons. Alfred Clark to Phillips Petroleum Company.

A synthesis and reactivation zone for Fischer-Tropsch reactions are described.

U.S.P. 2,564,964. Manufacture of Saturated Hydrocarbon Materials. Charles J. Engle to Phillips Petroleum Company.

Paraffin hydrocarbons are obtained from the corresponding olefins by heating the olefin with a hydrogen donor like cis-decalin in the presence of synthetic silica-alumina to 325-400°C. The olefin is saturated and the donor is converted to a naphthalene. The latter can be regenerated by hydrogenation.

U.S.P. 2,564,985. Hydrocarbon Synthesis Process. B. G. Mayland to Phillips Petroleum Company.

A synthesis process is described which employs an iron catalyst in fixed bed arrangement. When a portion of the catalyst becomes deactivated by oxidation to iron oxide, the direction of flow of the H_2 and CO feed is reversed to reactivate it. Reversal occurs at 10-45 minutes intervals. The center portion of the catalyst contains from 0.25—2 percent K_2O while K_2O concentration at the ends of the bed is 0.15—1 percent.

U.S.P. 2,566,337. Method of Controlling Exothermic Gas Reactions. L. S. Kassel to Universal Oil Products Company.

In exothermic catalytic gas reactions, particularly in the production of hydrocarbons from a CO/H_2 mixture, the temperature in the bed of solid catalyst is controlled by passing therethrough countercurrently to the flow of the CO/H_2 mixture a heated liquid mixture of a volatile component and a relatively non-volatile component, particularly a liquid hydrocarbon fraction containing a light narrow-boiling range fraction and a heavy substantially non-volatile fraction having an initial b.p. substantially higher than the end b.p. of the volatile fraction. The light fraction removes the exothermic heat of reaction by its vaporization while the heavy fraction prevents any temperature gradient throughout the catalyst bed because of the decreasing volatility of the light fraction during the downward passage through the catalyst bed and the decreasing volume of reactants as they pass upwardly through this bed.

U.S.P. 2,566,620. Manufacture of Synthesis Gas. B. J. Mayland and A. Clark to Phillips Petroleum Company.

Methane is introduced in a fluidized bed of small iron oxide particles suspended in a gas flowing sufficiently slow that the bulk of the particles is maintained together as a dense highly agitated phase. The average oxygen concentration in the bed is maintained at 18-23 percent by weight. The temperature is maintained sufficiently high to liberate oxygen from the iron oxide and to oxidize the methane for the production of a CO/H_2 mixture.

U.S.P. 2,566,936. Process for Preparing Synthesis Gases. A. D. Garrison to

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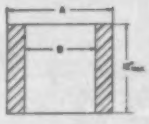

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Texaco Development Corporation.

In the production of a H_2/CO mixture of the mole ratio 2:1 from gaseous hydrocarbons, a bed of refractory material is heated to a temperature above that required for cracking the hydrocarbons to carbon and gases, whereupon the hydrocarbons are contacted with this bed under these conditions. The refractory material with the carbon deposit thereon is then contacted with a mixture of steam and hydrocarbon gas containing at least two moles of steam per mole of gas at a temperature above 1600° F. to produce the synthesis gas.

U.S.P. 2,567,259. Catalytic Conversion with a Fluidized Solid Catalyst. C. W. Watson to The Texas Company.

In a Fischer-Tropsch synthesis or other catalytic conversion of gaseous reactants, the reactants are passed upwardly through a reaction zone comprising a constricted, vertically extending passageway which has a hydraulic radius not greater than about one inch and occupied by a coarse dispersing fraction of inert solid particles of uniform diameter. The particles of the catalyst fraction are substantially smaller than those of the inert particles. Further details are claimed.

U.S.P. 2,567,295. Method for the Synthesis of Hydrocarbons with a Reduced Gamma Iron Oxide Catalyst. W. O. Milligan and J. C. Schiller to Standard Oil Development Company.

A CO/H_2 mixture is passed at a temperature of 450-675° F. and a pressure of 10-600 psi. over a catalyst mass prepared by the reduction at a temperature of 750-1400° F. of a mixture of Fe_2O_3 in the form of gamma oxide crystals and an amount of 1-15 percent by weight based on the oxide of an alkali metal stabilizing agent. Hydrocarbons and oxygenated hydrocarbons are produced.

U.S.P. 2,567,296-7. Preparation of a Fischer-Tropsch Catalyst. W. O. Milligan and J. C. Schiller to Standard Oil Development Company.

These patents claim the production of a catalyst of the type employed in the Fischer-Tropsch synthesis according to U.S.P. 2,567,295.

U.S.P. 2,567,342. Resinous Products from HF Acid-Soluble Oils. L. C. Morris to Phillips Petroleum Company.

An acid-soluble oil fraction obtained from the acid phase of an alkylation process using a HF catalyst is passed to a hydrogenation zone where it is treated in the presence of a catalyst under hydrogenating conditions comprising a temperature of 200-750° F. and a pressure 1000-2500 psi. The hydrogenation effluent is distilled to obtain a bottom product of a normally solid hydrocarbon resin.

U.S.P. 2,567,596. Synthesis of Hydrocarbons. A. Clark to Phillips Petroleum Company.

A CO/H_2 mixture is passed over a synthesis catalyst at a temperature of 150-400° C. under conditions such that gaseous and liquid hydrocarbons are formed. The feed mixture is passed in a direction having a horizontal component through a narrow continuous catalyst zone elongated in this direction, and liquid formed is continuously drained

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downwardly by gravity to the bottom of the catalyst zone and is immediately removed.

U.S.P. 2,566,065. Processes for Photochemical Chlorination of Hydrocarbons. A. Leverde and W. S. Beanblossom to the U. S. Atomic Energy Commission.

An alkyl substituted mononuclear aryl hydrocarbon, such as xylene, mesitylene, or cymene, is reacted with elemental chlorine under actinic light for at least several hours while maintaing an initial temperature of 25-120° C. but below the decomposition temperature of the hydrocarbon. The resultant partially chlorinated hydrocarbon is further chlorinated at gradually increasing temperatures up to a maximum of about 170° C. until at least 50 percent of the hydrogen in the chain of the molecule has been replaced by chlorine.

U.S.P. 2,566,146. Preparation of Vinyl Halides. F. L. Schouteden and R. G. Tritsmans to Gevaert Photo-Production N. V., Belgium.

A gaseous mixture of acetylene and HCl is contacted at elevated temperature with a solid catalyst containing $HgCl_2$ and a solid synthetic resin, particularly a polymeric resin. Vinyl chloride is produced. Volatalization and loss of catalytic substance is reduced by the presence of the resin.

U.S.P. 2,566,355. Process of Preparing Olefin Chlorohydrins. M. Neuhaus to Jefferson Chemical Company, Inc.

Ethylene and/or propylene chlorohydrins are produced by diffusing a stream of the corresponding olefin and chlorine into a body of an aqueous solution of hypochlorous acid and other reaction products of the reaction between chlorine and water. Further details are claimed.

Re. 23,404. Reaction of Organic Compounds with Hydrogen Halides. A. I. Gebhart to Colgate-Palmolive-Peet Company.

Styrene is hydrobrominated by contacting bromine in liquid SO_2 medium with water and intimately contacting the resulting mixture of HBr, H_2SO_4, and liquid SO_2 with styrene. Bromoethylbenzene is obtained.

U.S.P. 2,567,254. Process for Preparing Nitriles and Pyridines. J. W. Teter to Sinclair Refining Company.

A mixture of butadiene and ammonia in molar proportions less than 1:5 is contacted at a temperature of 500-700° F. and a pressure in excess of 500 psi. with a catalyst containing as the active component a reduced oxide of Ni or Co. Aliphatic nitriles and pyridines are produced.

U.S.P. 2,567,569. Perfluorination of Hydrocarbons with Lead Tetrafluoride. E. T. McBee and R. M. Robb to Purdue Research Foundation.

Alkanes or alkenes are reacted with PbF_4 at a temperature between 50° C. and that at which decomposition of the organic reactant occurs. Perfluoroparaffin is obtained.

U.S.P. 2,567,759. Fluorination of High Molecular Compounds. A. F. Benning to U. S. Atomic Energy Commission.

A mixture of high-boiling hydrocarbon vapors and a large volume of HF vapor is contacted with cobalt trifluoride, silver difluoride or manganese trifluoride at a temperature of 150-400° C. Highly fluorinated high molecular products are obtained.

U.S.P. 2,567,854. Production of Alkyl Aromatic Sulfonic Acids and Their Salts. I. G. Nixon to Shell Development Company.

Details are claimed of a process for manufacturing water-soluble salts of alkyl aromatic sulfonic acids by alkylating a monocyclic aromatic hydrocarbon with a fraction of petroleum cracking products containing 15-30 percent alkenes in admixture with branched chain and cyclic hydrocarbons.

William Warren Joins SOD

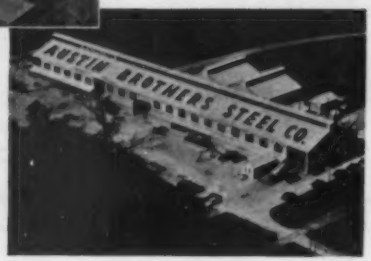
William J. Warren, formerly a professor of electrical engineering for the University of Santa Clara, and a part-time consultant for industrial firms since 1941, has been assigned to the associate directors' staff of Shell Oil Development Company which he joined recently. Warren received his Ph.D. in electrical engineering at the University of Illinois in 1936.

Gray Joins Lion Oil

John H. Gray, recently named director of public relations for Lion Oil Company, formerly served in an executive position with the *Wall Street Journal's* Southwest edition in Dallas. A native of Newark, N. J., Gray is a graduate of Cornell University. Gray, his wife, their daughter Jan and son Hunter, will live in El Dorado, Ark.

SERVING THE INDUSTRY

FROM 2 GREAT PLANTS



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• Steel Warehouse Products

AUSTIN BROTHERS STEEL CO.

GENERAL OFFICES:
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DALLAS 1, TEXAS

STEEL

PLANTS:
DALLAS, TEXAS
HOUSTON, TEXAS

BOOKS of Current Interest

Review and Comment for the Process Man

Spindletop Saga

Spindletop, Where Oil Became an Industry, 1901-1951, Official Proceedings of the Spindletop 50th Anniversary Commission, P. O. Box 3150, Beaumont, Texas. $3.50.

Published as a souvenir memento of the fiftieth anniversary of Spindletop, this volume contains complete proceedings and addresses of the entire celebration. Messages by such men as B. Brewster Jennings, president of Socony-Vacuum Oil Company, Inc., Charles Ebem Wilson, president of General Motors Corporation, David Rockefeller, vice president of Chase National Bank, and other well known men, will be of interest to those who were not in attendance.

Avgas Research

Aviation Gasoline and Its Component Hydrocarbons: Wartime Research, 1940-45, H. M. Smith, A. J. Kraemer, and H. M. Thorne. Bulletin 497, Bureau of Mines, United States Government Printing Office, Washington, $1.50.

This report is a summary of research conducted by the Bureau of Mines on aviation gasoline and its components between the dates given. The work included surveys of crude oils and condensates for distillates suited to aviation gasoline, blending to make high-octane products, and superfractionation and desulfurization to utilize marginal stocks. Data on losses of aviation gasoline by evaporation, on sources of toluene and waxes from petroleum and on capacities of refineries were developed.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

Cyclobutyl carbinol
Cyclobutyl bromide
Vinyl-*p*-xylene
p,p'-Di(dimethylamino)benzohydrol
α,α-Dichloroacetone
O-Phthalamic acid
2-Methylthiazole
Fluorodiiobomethane
m-Ethylbenzaldehyde
Dodecyl gallate
4,4'-Diphenyldiphenyl
Dioctyl thioether
1,4-Dimethylnaphthalene
9,10-Dihydrophenanthrene
Benzene-1,2-disulfonic acid
Chloronitromethane
N-Vinylpiperidine
Benzoquinonecarboxylic acid
3,4,5-Trichlorobenzaldehyde
Triacontane
Cyclobutane

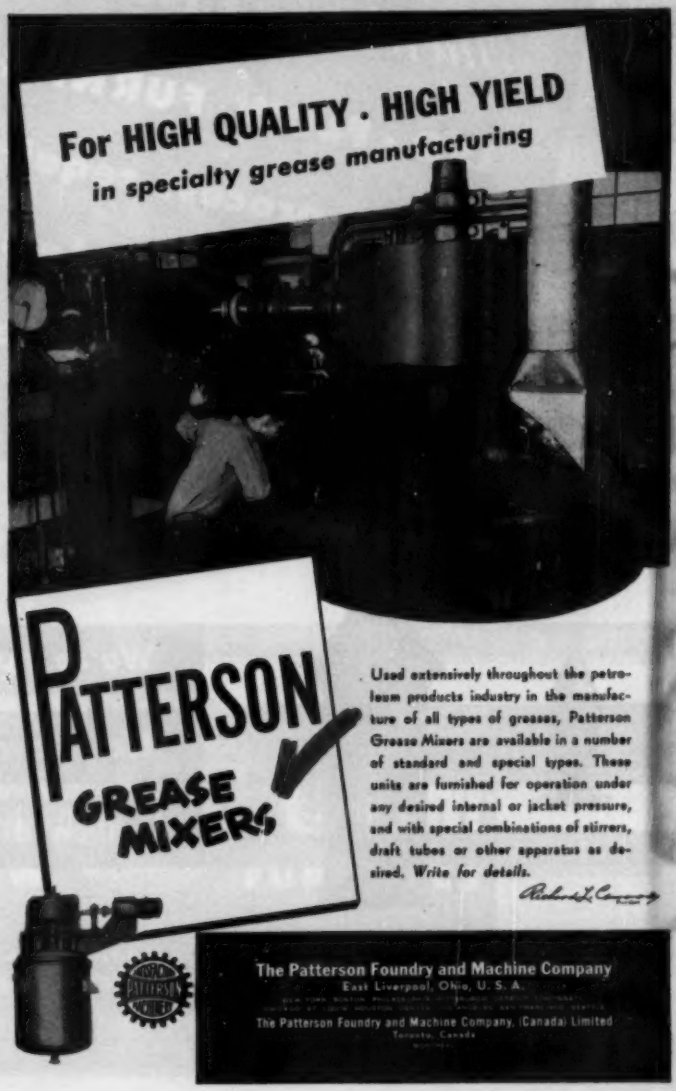
Mineral Oil Analysis

Aspects of the Constitution of Mineral Oils, K. Van Nes and H. A. Van Westen, Elsevier Publishing Company, Inc., 250 Fifth Avenue, N. Y. $9.

The primary object of this book is the introduction of an unpublished method for structural group analysis, however it is a fairly comprehensive survey of all present knowledge concerning the constitution of mineral oils. The new method referred to can be considered as a revision of the "Waterman analysis," is based on the same principles, but incorporating experimental background and simpler application. The material incorporated was gathered in the Koninklijke / Shell-Laboratory, Amsterdam, by employes of the Bataafsche Petroleum Maatschappij.

Lab Nears Completion

A new three-story laboratory building at Ponca City, Okla., is expected to be completed this fall for occupancy by Continental Oil Company. The $2,250,000 structure is being erected by Wigton-Abbott Corporation. Administration space is being added also.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PATTERSON
GREASE MIXERS
Used extensively throughout the petroleum products industry in the manufacture of all types of greases, Patterson Grease Mixers are available in a number of standard and special types. These units are furnished for operation under any desired internal or jacket pressure, and with special combinations of stirrers, draft tubes or other apparatus as desired. Write for details.
The Patterson Foundry and Machine Company
East Liverpool, Ohio, U. S. A.
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Toronto, Canada

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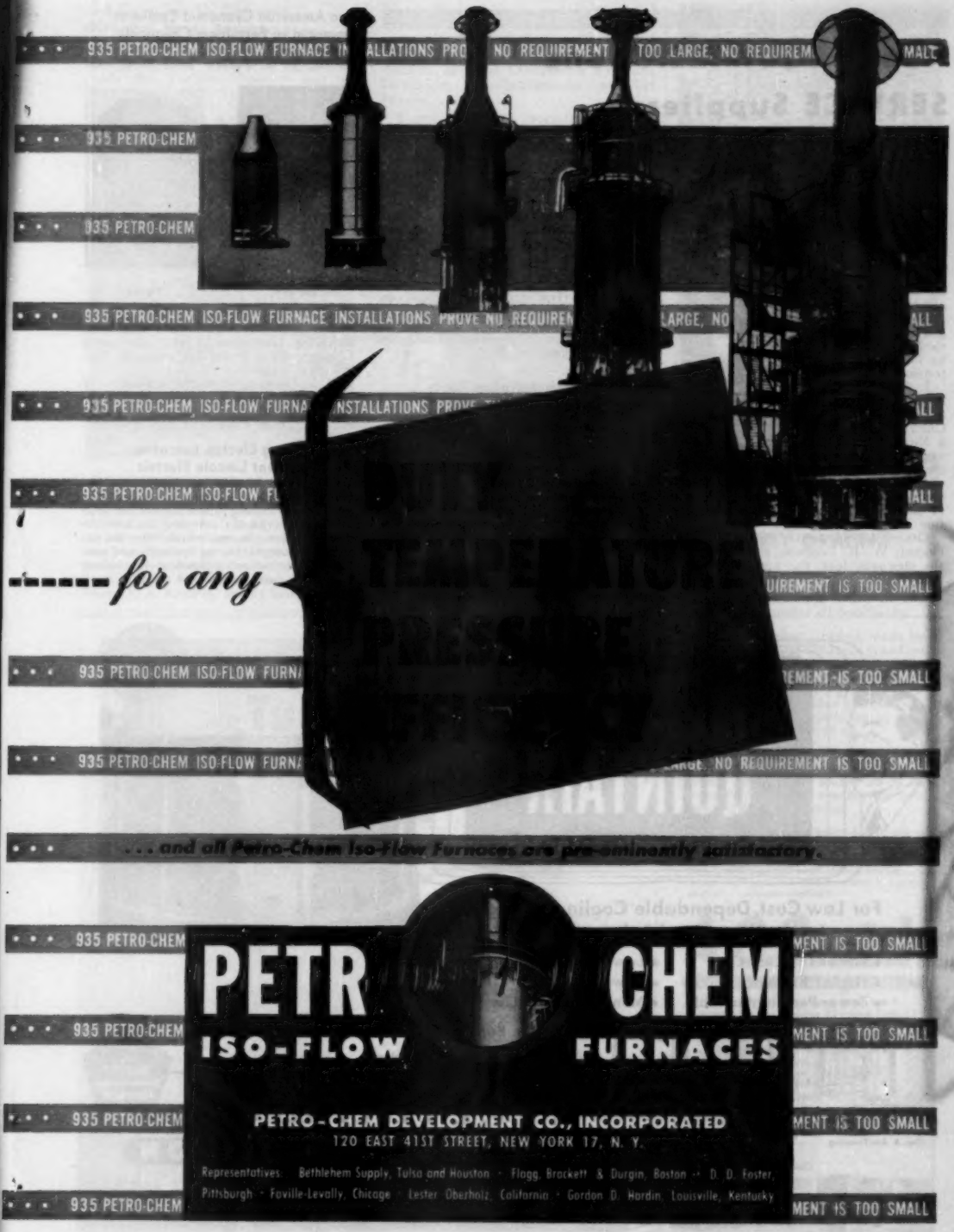
There's a

ISO-FLOW FURNACE for every process requirement for the petroleum and chemical industries.

We're now building two Iso-Flow heaters of 159 million BTU capacity each.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for any
. . . and all Petro-Chem Iso-Flow Furnaces are pre-eminently satisfactory.
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Representatives: Bethlehem Supply, Tulsa and Houston · Flagg, Brackett & Durgin, Boston · D. D. Foster, Pittsburgh · Faville-Levally, Chicago · Lester Oberholz, California · Gordon D. Hardin, Louisville, Kentucky

About EQUIPMENT and SERVICE Suppliers

Four Worthington Employes Named In Promotional Job Transfers

Formerly assistant manager of Worthington Pump and Machinery Corporation's Chicago district office, J. B. Laramy has been appointed manager of the Marketing Research Department at Harrison, N. J. A graduate of the University of Michigan, he joined Worthington in 1930.

Laramy

J. T. Carroll has been named assistant manager of the Chicago office. He is a Northeastern University graduate in mechanical engineering and joined the company in 1931. For the past three years he has been regional supervisor of the Air Conditioning and Refrigeration Division at Chicago.

Other appointments this month included: W. R. Leopold, an assistant to the vice president, was appointed to direct the operations of the Public Works Division of the Harrison plant. D. L. Gallagher has been appointed manager of the division.

Leopold, a Worthington employe since 1917, joined the firm as a sales trainee and was successively meter salesman, meter representative, sales manager, and division manager.. He lives in Upper Montclair, N. J.

Gallagher, a graduate of Rensselaer Polytechnic Institute, served the New York Power and Light Corporation seven years before joining Worthington as an application engineer. Gallagher lives in Ridgewood, N. J.

Pangborn Demonstration Room Shows Operation of Machines

A demonstration room for blast cleaning and dust control equipment has been provided by Pangborn Corporation at its plant in Hagerstown, Md. Machines on display range from a hard hitting 15-ton Roto-blast monorail installation to Pangborn's "Mighty Midget," a 90-pound miniature of Hydro-Finish, a liquid blasting process which can be used on materials as delicate as wrist watch gears. The demonstration room is supervised by Ralph R. Graver, a Pangborn engineer for 36 years.

Two American Cyanamid Employes Promoted to Petroleum Chemicals

American Cyanamid Company has appointed V. R. Farlow sales supervisor

Glespen

Farlow

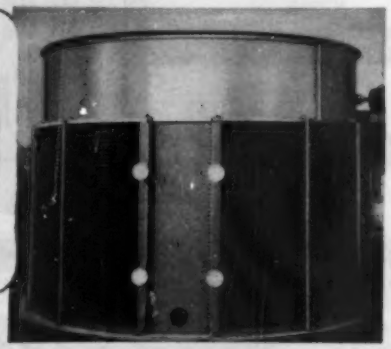
of the Petroleum Chemicals Department. Since 1945, Farlow had been technical representative in the company's Chicago office. F. E. Eck succeeds Farlow in Chicago.

G. L. Glespen, formerly supervisor of Catalyst Products in New York, has been appointed technical supervisor of the Petroleum Chemicals department.

Wm. Irrgang Elected Executive Vice President Lincoln Electric

The Lincoln Electric Company has elected William Irrgang executive vice president. Irrgang joined Lincoln in 1929 and has served the company as a methods engineer, during which time he developed manufacturing methods and machinery for reducing the cost of welding electrodes, and as director of plant engineering.

The NEW
Pritchard Quality
QUINTAIR*
AIR COOLED HEAT EXCHANGER



For Low Cost, Dependable Cooling of Engine Jacket Water and Lubricating Oil

- Lower Installed Cost
- Higher Efficiency
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- Lower Maintenance Costs
- Lower Operating Costs
- Many Industrial Uses

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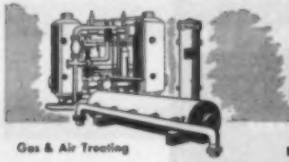
* Registered Trade Name



Gas & Air Treating

Specialized Heat Exchangers

Cooling Towers

Products of QUALITY Specialized Process EQUIPMENT

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EQUIPMENT DIVISION
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District Offices: CHICAGO • HOUSTON • NEW YORK • PITTSBURGH
TULSA • ST. LOUIS • Representatives in Principal Cities from Coast to Coast

G-E Organizes Six Divisions; Divisional Heads Announced

Six new operating divisions formed by the General Electric Company include the Turbine Division and the Motor and Generator Division, both with headquarters at Schenectady, N. Y.; Transformer and Allied Products Division, with headquarters at Pittsfield, Mass.; Measurements and Industrial Products Division, with headquarters at Lynn, Mass.; Switchgear and Control Division, with headquarters at Philadelphia; and the Component Products Division, with headquarters at Fort Wayne, Ind.

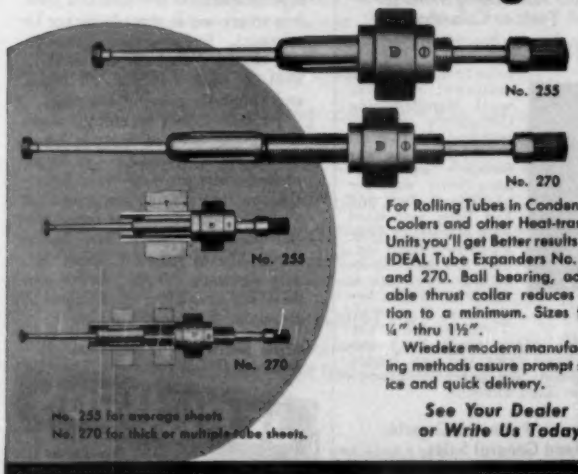
Together with the recently-announced Defense Products Division, the six new

SALES REPRESENTATIVES OF Union Malleable and its subsidiaries brought their wives along to the 1951 conference of the organization. All except the West Coast members of the parent company and Ashland Malleable Iron Company and the Union Brass and Copper Company met at Mansfield, Ohio, for a grand intermingling of business and recreation of sales representatives, company officials, business associates, and their wives. Pictured above, attending the 1951 conference, are Homer Sipe, Sol Jacobson, Charles Kates, Clarence Spencer, Joseph Leader, Ralph Meshel, Meyer Bressen, Earl Loftus, Leonard Grossman, Bert Gleichman, Lawson Yates, T. P. Curtis, William Biltzer, Ben Drachler, Harry Gorelik, Robert Gross, Frank Kafka, Ted Platz, Al Singer, H. A. Suseman, and Al Shoenberger. The West Coast group will meet at a later date.

IDEAL

Precision-Built for faster, smoother

Tube Rolling



No. 255 for average sheets
No. 270 for thick or multiple-tube sheets.

For Rolling Tubes in Condensers, Coolers and other Heat-transfer Units you'll get Better results with IDEAL Tube Expanders No. 255 and 270. Ball bearing, adjustable thrust collar reduces friction to a minimum. Sizes from ¼" thru 1½".

Wiedeke modern manufacturing methods assure prompt service and quick delivery.

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THE GUSTAV **WIEDEKE** COMPANY
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See the difference

A. O. SMITH SAFETY GRATING

Full 100% serration of all bearing bars and cross bars insures 360° non-slip protection . . . in any weather . . . under all conditions.

More Apex Safety Grating, made by A. O. Smith Corporation, is used on America's railroads than all other makes combined. For 15 years A. O. Smith *locked-for-life* grating construction has provided the ultimate in strength and reliability in this, the severest service of all.

Now this time-proved safety grating is available for industrial applications. You owe it to the safety of your employees to specify this outstanding safety grating.

Let A. O. Smith put your plant on a safe footing.

Stair Treads . . . and plain surface grating . . . where maximum non-skid protection is not essential . . . are also available.

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A FEW TERRITORIES STILL OPEN TO DISTRIBUTORS

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Grating Division, Dept. PR-1151
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Without obligation send me complete information on your Safety Grating.

Name _____
Firm _____
Address _____
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☐ I am interested in a Distributorship.

Stop corrosion with

Hysol 4000 Coatings

Wherever chemicals, caustic atmospheres, salt or fresh water cause corrosion . . . Hysol Coatings can save money for you. These tough chemical and abrasion-resistant films adhere strongly to all metal surfaces. They can be applied by brush, spray, dip or roller methods with your own personnel—or when practicable we are equipped to apply the coating in our plant. Although they dry quickly in air, forced drying under moderate temperature is recommended for applications which are particularly corrosive. The finished coating is available in eight colors.

Describe your corrosion problem on your letterhead, and let us show how Hysol Coatings can save money for you.

houghton laboratories, inc.
OLEAN, NEW YORK

PLANTS AT OLEAN, N. Y., AND SMETHPORT, PA.

divisions include the majority of the departments which constitute the former Large Apparatus Division and Small Apparatus Division.

Glenn B. Warren, Schenectady, has been appointed general manager of the Turbine Division.

James M. Crawford, of Pittsfield and formerly of Schenectady, was named general manager of the Motor and Generator Division.

Francis E. Fairman, Jr., of Schenectady and formerly of Pittsfield, was made general manager of the Transformer and Allied Products Division.

George E. Burens, of Baltimore, is general manager of the Switchgear and Control Division.

Harold E. Strang, of Lynn and formerly of Scotia, N. Y., was named general manager of the Measurements and Industrial Products Division.

William C. Wichman, of Fort Wayne, is the general manager of the Component Products Division.

Steam Company Names Arthur Sy Vice President Charge of Sales

Arthur H. Sy, formerly sales manager, has been named vice president in charge of sales for American District Steam Company Inc., North Tonawanda, N. Y. A member of the company since 1923, Sy served in production, engineering and sales, before becoming sales manager in 1946. He will assume responsibility for main sales functions as well as supervision of the five district sales offices in Buffalo, Chicago, New York, Philadelphia and Pittsburgh, and the 46 manufacturers' representatives in 70 principal cities.

Sy

Owen Named Advertising Manager Of Rockwell Tools at Columbus

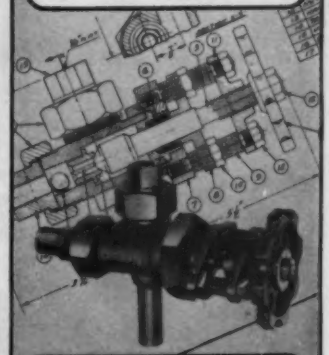
Samuel P. Owen, advertising specialist in portable power tools, has been appointed advertising manager of Rockwell Manufacturing Company's recently acquired Rockwell Tools, Inc. He was formerly assistant advertising manager of Skilsaw, Inc., and had been associated with Marsteller, Gebhardt and Reed, Inc., and has had direct selling experience in Rockwell Tool's key markets. Rockwell Tools, located in Columbus, Ohio, specializes in the manufacture of hand saws and saw blades. It will augment the parent company's Delta Power Tool Division.

Owen

Hills-McCanna Promotes Grassle; Kidde to Head General Sales

Hills-McCanna Company of Chicago recently promoted Fred R. Grassle and R. T. Kidde. Grassle, secretary of the corporation, has been appointed assistant to president C. A. Howe. He will retain his duties as secretary. Kidde has been appointed general sales manager

BEST FOR HIGH TEMPERATURE AND CORROSIVE SERVICES



JERGUSON OS&Y VALVES
Eliminate Stem Freezing

YOU'LL be sure of dependable performance under high temperature or corrosive service conditions when you use rugged Jerguson Outside Screw and Yoke Valves.

These Jerguson OS&Y Valves are made to withstand severe service, and are the ideal answer for high temperature and corrosive services where inside threads cannot be tolerated. Jerguson's efficient outside thread design allows the valve stem to work freely at all times, and forestalls possible freezing.

Jerguson OS&Y Valves are available in any alloy in order to better handle corrosive media; can be repacked under pressure; have renewable and regrindable seats; and are available with Teflon or other special packing. Outlets may be on center line of valve, or offset 7/8". *The Jerguson OS&Y feature may be added to existing installations of Jerguson #50 or #60 Valves.*

Write for full information on Jerguson OS&Y Valves

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Follsway, Somerville 45, Mass.
Representatives in Major Cities
Phone Listed Under JERGUSON
Jerguson Trans Gage & Valve Co. Ltd., London, Eng.

these steam traps won't freeze up!

Freeze-ups of outdoor steam traps in winter weather often cause production delays. Don't take that chance . . . especially when it's so easy to install Yarways, the steam traps that *won't freeze up.*

They won't freeze because condensate does not accumulate. The only moving part—a little valve—is continually testing for condensate, discharging it as soon as it forms. There's never anything to freeze.

Other reasons why over 750,000 Yarway Impulse Steam Traps have been sold—they get equipment hotter, sooner; light weight; small size; easy to install and maintain; good for all pressures; made of stainless steel.

More than 200 industrial distributors sell Yarway Traps and Strainers. See your nearest one today. For name, and free 24-page Steam Trap Book, write . . .

YARNALL-WARING COMPANY
128 Mermaid Ave., Philadelphia 18, Pa.

YARWAY

the steam trap designed with more production in mind

KEROTEST

NEEDLE VALVES

FORGED STEEL for HIGH PRESSURE AND CORROSIVE SERVICES

Globe and angle types in specific materials for ordinary or corrosive services. 8000 lb. working pressures at 150 deg. F. Safety union bonnet design permits packing under pressure. Conical stem tip gives micrometer throttling action. Sizes ⅛" to ¾".

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KEROTEST MANUFACTURING COMPANY
Pittsburgh 22, Pa.
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Tulsa Odessa Houston Los Angeles
St. Louis Toledo Richmond Baltimore

of all Divisions. Hills-McCanna manufactures valves, proportioning pumps, force feed lubricators and graphic arts supplies, and operates a magnesium foundry.

B, S & B Appoints Tidd Manager Contract Sales at Oklahoma City

Lu N. Tidd has been named manager of contract sales for the Oklahoma City plant of Black, Sivalls & Bryson, Inc. Tidd has been an officer of the company since 1950, in the capacity of assistant treasurer and assistant secretary.

Tidd

Before his present appointment to manager of contract sales for Oklahoma City, Tidd was general credit manager for five years.

His appointment was announced by Henry A. Ruysser, Jr., vice president and general sales manager for the company.

Oronite Appoints Dr. Elwell Product Development Manager

Dr. W. E. Elwell, appointed manager of eastern product development for Oronite Chemical Company, a wholly-owned subsidiary of Standard Oil Company of California, will make his headquarters in New York City.

Elwell

As supervisor of chemical products for California Research Corporation, another Standard of California subsidiary, he gained experience in organic chemicals currently being developed by Oronite. A member of the California Standard organization since 1938, Dr. Elwell received a Ph.D. degree from the University of Washington, and a B.S. degree from the College of Puget Sound.

B & W Tube Transfers Two Sales Personnel Between Houston-Tulsa

The Babcock & Wilcox Tube Company has transferred two men in its sales organization. J. H. Roach, formerly located at Tulsa, has been transferred to Houston and named assistant sales manager of the Houston office. A native

EXCEL-SO
SEPARATORS
Coalesce and remove all free water from light petroleum products.
WARNER LEWIS COMPANY
P. O. BOX 3096-D • TULSA

SAFE STRONG SECURE

Before specifying or purchasing open steel flooring check these exclusive features of Blaw-Knox Grating . . .

1. SAFETY underfoot at all times assured by twisted steel cross bars.
2. STRENGTH that only rigid "one-piece" Electroforged construction can provide.
3. SECURITY—no wobble, tilt or rattle caused by loose or lost screws, nuts, bolts.
4. EASY to maintain and paint . . . no sharp corners to clog with dirt.
5. MAXIMUM open area for light and air.

For complete data on Blaw-Knox Electroforged Steel Grating and Stair Treads write for Bulletin 2365.

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Electroforged®
STEEL GRATING
AND STAIR TREADS

of Houston, he has been with the company since 1939, and served as assistant district sales manager at Tulsa since 1946.

W. C. Mohrman, located at the Houston office has been transferred to Tulsa and named a district salesman. A native of Houston, he graduated from Rice Institute in 1946, just prior to joining Babcock & Wilcox.

OPERATION OF GONIOMETERS was explained to I. H. Milne (center), Gulf Research & Development Company, and to O. E. Robbins (left), Shell Oil Company, by C. J. Woods of the Research & Control Instruments Division of North American Philips Company, Inc. The session took place during the eleventh semi-annual X-ray diffraction school held at the North American Philips plant in Mount Vernon, N. Y., recently. Over 100 scientists and technical men attended.

American Meter Appoints Cutter Assistant-Sales Vice President

American Meter Company, manufacturers of equipment for the measurement and control of gases and other fluids, has appointed Earl B. Cutter as assistant to the vice president in charge of sales.

Cutter

Cutter, a 1939 graduate of Iowa State University with a B.S. degree in Mechanical Engineering, joined the American Meter Company shortly thereafter. His association with the company was interrupted in 1941 by active service with the U. S. Army Corp of Engineers. In 1946 Cutter returned to the American Meter organization and has been active in sales in the Mid-West.

Allis-Chalmers Organizes Units Into Power Section Under Casper

The electrical and mechanical power departments of Allis-Chalmers Manufacturing Company have been combined into a power department under the management of R. M. Casper. As part of the organizational change, the centrifugal pump department becomes a section of the power department under the management of H. P. Binder, a post he has held since 1942.

Casper has been manager of Allis-Chalmers electrical department since 1949. He joined the company in 1936 as a sales representative in the Detroit office. In 1942 he was named sales engineer in charge of motor and generator sales in Allis-Chalmers electrical department, and in 1947 he became manager of the motor and generator section.

New power department appointments include: F. W. Bush, assistant manager in charge of the electrical sections; C. C. Jordan, assistant manager in charge of the mechanical sections; R. N. Miers, manager of the steam turbine section; C. R. Braun, assistant to R. M. Casper, and E. J. Schiebenes, office manager of the power department.

Bush, who has been with Allis-Chalmers since 1928, had been assistant manager of the electrical department since 1946. Prior to that he was assistant to the manager of the electrical department and sales engineer-in-charge of transformer sales.

Jordan, who joined Allis-Chalmers in 1923, was named manager of the central station and industrial sales department in 1948 and more recently had been manager of the steam turbine section.

Miers, newly named manager of the steam turbine section, has been associated with the company's steam turbine department since 1928. He was successively resident turbine specialist serving east coast offices, and manager of the mechanical drive and industrial turbine section before being named mana-

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B-H BLANKETS

The Black Rockwool Insulation

Currently starring in the B-H review of insulating materials are B-H Blankets, felted between layers of any combination of: wire mesh and metal lath reinforcements to suit requirements. Some outstanding advantages of this versatile performer are:

- Effective to 1200°F
- 2' x 4' and 2' x 8' standard sizes
- Special sizes available
- Fast, easy, large-area application
- Fits curved surfaces
- Interlocking edges
- Incorporates lath for finishing cement
- High moisture resistance

Baldwin-Hill can help you cut down heat loss... by recommending a material and method of application from its *complete* line of *Black* Rockwool insulations. For most efficient heat control at lowest cost—with blanket, block, cements, etc.—call in a THERM-ENOMICS* consultant.

**Economics of Engineered Heat Control*

IF IT'S TOO HOT TO TOUCH

IT NEEDS INSULATION

Black Rockwool

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clip this coupon and attach to your signed letterhead
SEND ME COMPLETE INFORMATION ON:

- ☐ Mono-Block—for temperatures to 1700°F
- ☐ Blankets—metal reinforced, large-area coverage to 1200°F
- ☐ No. 1 Cement—plastic insulation, to 1800°F
- ☐ Powerhouse Cement—high-adhesion finishing to 1700°F

BALDWIN-HILL CO., 782 BREUNIG AVE., TRENTON, N. J.

ger of the sales section of the department in the early part of 1948.

Braun came to Allis-Chalmers in 1940 and was supervisor of the marine sales division in the steam turbine department before being named assistant to the manager of the mechanical power department.

Schiebenes, an Allis-Chalmers employe in various capacities for more than 40 years, had been office manager of the steam turbine department for many years.

Conoflow Opens Auxiliary Plant In Philadelphia This Month

Conoflow Corporation this month opened an auxiliary plant to enlarge its manufacturing facilities in the Philadelphia area. Plant No. 2, fronting on Twenty-first and Van Pelt Streets, will accomodate the assembly and shipping division.

General Controls Names Managers For Offices at Omaha, New Orleans

General Controls Company recently named two branch managers for their newly opened offices in Omaha and New Orleans. The new office in New Orleans, located at 426 Audubon Building, will be directed by Robert C. Servat. He will take charge of territory activities, including sales, engineering and services.

Servat

Burnett

Eldon Burnett, who joined General Controls in Glendale three years ago, has been named manager of the branch office at Omaha, Neb. Burnett attended both Emporia State College and the University of California, and was associated with Charles D. Jones & Company, Kansas City, before joining the General Controls staff as a sales engineer.

Rockwell Executive Appointed NPA Chief, Valves and Fittings

A. J. Kerr, vice president of meter and valve sales for Rockwell Manufacturing Company has been appointed chief of the Valves and Fittings Branch, General Components Division of the National Production Authority. He will work under direction of Eugene S. McCarthy, director of the General Components Division, and will headquarter in Washington, D. C. Charles W. Burrage, whom he succeeds, is returning to his job at The Lunkenheimer Company, Cincinnati, Ohio.

Kerr

Kerr is a mechanical engineering graduate of Carnegie Institute of Technology and was formerly a director of the American Society of Mechanical Engineers. He has been associated with Rockwell for 25 years and was district sales manager of the Tulsa office until 1944 when he came to Pittsburgh as general sales manager.

Seven Worthington Plant Officers Given Promotions and New Posts

Seven Worthington Pump and Machinery Corporation executives were named to new plant posts recently. George P. Passmore, formerly works manager at Wellsville, N. Y., was named assistant to the vice president in charge of manufacturing at Harrison, N. J. He will be concerned with machine shop processes and facilities, except welding, in all plants. A Worthington employe since 1941, he was associated with Westinghouse Electric Corporation at Philadelphia for 21 years.

Passmore

A. M. Tullo, assistant works manager at Harrison, has been appointed works manager at Wellsville to replace Passmore. He joined Worthington in 1923 and worked in both the Centrifugal Engineering and Estimating Departments. During the war he laid out, equipped and operated the Newark plant.

John Burlick, formerly manager of the Methods and Standard Department, and Max A. Heyman, manager of the Production Department at Harrison,

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have been named assistants to the works manager at the Harrison plant.

Other new appointments for the Harrison plant included those of W. D. Sizer, manager of the Regional Engineering and Service Department; George F. Habach, executive engineer; and Everett Schmachtenberg, chief engineer of the Centrifugal Engineering Division.

A. O. Smith Names Two Top Sales Division Executive Promotions

Promotion lists at the A. O. Smith Corporation, Milwaukee, include the names of J. W. Spoor, L. F. Vonier and Charles Smith.

Spoor, formerly Product Service Division manager, has been named general sales manager of the Welding Products Division at Milwaukee. He will be succeeded in the Product Service Division by Charles Smith, formerly field service manager.

Vonier, former sales manager, is moving into the newly-created position of sales promotion manager, with headquarters in Milwaukee. He has worked with development of A. O. Smith's welding electrode line since 1937.

Dumser Joins Wolverine at Detroit as Sales Assistant

John M. Dumser has been appointed assistant to the general sales manager of the Wolverine Tube Division of Calumet and Hecla Consolidated Copper Company. He joined the company late last month and will headquarter at the company's general sales offices in Detroit. George D. Potter is the general sales manager.

Munn Assigned to Nordstrom Sales of Oil Field Products

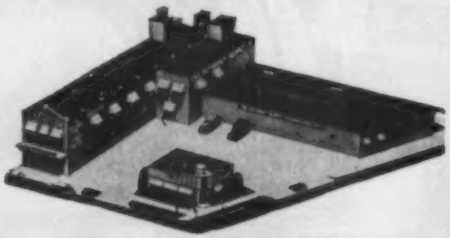
R. J. Munn, recently appointed assistant sales manager of Oil Field Products for Rockwell Manufacturing Company, will transfer his headquarters to Pittsburgh where he will assist H. Gottwald, general sales manager of the Nordstrom valve Division. Formerly Munn was a sales engineer for the division, with headquarters in Houston. A graduate of Texas A. & M. College, he has served Rockwell at its Corpus Christi office, and also worked as a roughneck in the oilfields. He was associated with Bethlehem Supply Company at one time.

Munn

Behm Appointed Assistant for G-E Small Apparatus Engineering

J. Herbert Behm, appointed staff assistant to the manager of engineering of General Electric's Small Apparatus Division, will make his headquarters at Lynn, Mass.

A former resident of Syracuse, N. Y., Behm graduated from Syracuse University with an electrical engineering degree in 1929. He joined G. E. at Schenectady, N. Y., and in 1931 was transferred to a Fort Wayne, Ind., assignment in fractional-horsepower motor engineering. He served as assistant



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division engineer for aircraft and a-c motors, more recently assuming the position of division engineer for a-c motors. He was appointed as assistant to the manager of fractional-horsepower motor engineering in July.

Neil Thomas Joins Chiksan's Sales Headquarters in Newark

C. E. (Neil) Thomas, who joined the sales staff of Chiksan Company, Brea, Calif., in July, has been assigned to Chicksan's eastern headquarters in Newark, N. J. A native of New Jersey, he graduated from Lafayette College in 1941, served with the Coast Guard until 1946, and then entered Rutget's Law School. Subsequently he was associated with the General Cable Corporation as sales representative for the New Jersey area. Thomas, his wife, and young son, reside in Westfield, N. J. where he serves as a Civil Defense Zone Warden.

Thomas

Lewis Elected Vice President of Ethyl Antiknock, Ltd., Canada

Oscar B. Lewis has been elected vice president of Ethyl Antiknock, Ltd., Canadian subsidiary of Ethyl Corporation, to succeed William M. Turnley, retired. An Ethyl employe for 24 years, Lewis has been general manager of the Canadian company for the past year. He has served in the United States, England and Canada. A native of Brooklyn, N. Y., he attended Dartmouth College and Columbia University and during World War II served on the Engineers' Joint Committee of the National Defense Advisory Commission, later cited for its work.

Lewis

Worthington Appoints Rasmussen Executive Engineer, Wellsville

H. V. Rasmussen has been appointed executive engineer at the Wellsville, N. Y., plant of Worthington Pump and Machinery Corporation.

Rasmussen graduated with an M.E. degree from the Institute of Technology, Copenhagen, Denmark, in 1920 and did graduate work at the Massachusetts Institute of Technology.

He spent a number of years with both the Westinghouse Electric Corporation and the DeLaval Steam Turbine Company, and during World War II was a consultant for National Defense Research at Columbia University, and a representative on both the Navy-Industry Committee on Propulsion Turbines and the advisory committee of the International Electro-Technical commission.

Rasmussen is a member of the American Society of Mechanical Engineers and a civilian member of the American Society of Naval Engineers.

Mic-Lin Offers Close Tolerance Machining to Teflon Line Service

The Mic-Lin Company recently added the specialized machining of rods and tubes to close tolerances to their services. Manufacturers of Teflon gaskets, packing rings, etc., their executive offices in the Land Title Building, Philadelphia, are headed by Ed Walsh. Teflon is a plastic material characterized by extreme inertness to chemicals, unusual heat-resistance, excellent electrical properties and a surface to which nothing will adhere firmly.

Lloyd Elected Vice President of Raw Materials for U. S. Steel

Robert M. Lloyd was recently elected vice president of raw materials of the United States Steel Company. Lloyd, who joined the company in the sales department of the Carnegie-Illinois Steel Corporation in 1926, subsequently served as assistant director or raw materials, assistant to the vice president in 1945, and assistant vice president in 1951. Lloyd is a graduate in electrical engineering of the University of Pittsburgh, and in metallurgy from Carnegie Institute of Technology.

Timken Moves Humphrey to Canton To Assist the General Manager

George T. Humphrey, Jr., has been appointed assistant general manager of the Service Sales Division at Canton, Ohio, for the Timken Roller Bearing Company. Humphrey was instrumental in developing Timken Company distribution center in Mexico and in promoting Timken Rock Bit sales there.

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A mechanical engineering graduate of S. M. U., he moves up from assistant branch manager at Dallas.

Black, Sivalls & Bryson Name Pike S. A. Sales Representative

Allen Pike of Oil Field Sales & Service, C. A. of Anaco, Venezuela, has been appointed by Black, Sivalls & Bryson as South American representative for their entire line of oilfield equipment.

M. H. Detrick Company Moves Houston Sales-Service Offices

Texas and Gulf Coast district sales and service offices for the M. H. Detrick Company of Chicago, have been moved to 2284 Holcombe Boulevard, Houston. Detrick makes flat suspended arches, sectional supported walls and insulation.

Campbell Takes Over Mid-West Sales for Wolverine Division

E. J. Campbell has been appointed Mid-Western district sales manager of the Wolverine Tube Division of Calumet and Hecla Consolidated Copper Company.

Campbell

Campbell has been affiliated with the Company since 1943 and was responsible for both establishment of the company's Grand Rapids, Mich., sales office in 1945 and the widespread development of sales activities in western and southwestern Michigan. He was promoted to assistant Mid-Western district sales manager in 1948.

Campbell will maintain headquarters at Number One North LaSalle Street, Chicago.

Conoflow Leases Philadelphia Unit to Expand Manufacturing

Conoflow Corporation, Philadelphia, has opened an auxiliary plant to take care of expanded activities necessary to service many high-priority defense orders in pneumatic control equipment. Plant Number 2, which fronts on 21 Street extending through to Van Pelt street, accomodates the assembly and shipping division. The move was made in late October.

Van Campen, Robert Smith Named New Clark Bros. Sales Managers

Two district sales managers and one industrial sales engineer were announced recently by Clark Bros. Company, Inc. of Olean, N. Y.

Van Campen

Daniels

A. G. Van Campen named district sales manager of the Tulsa Mid-Continent territory formerly served in that capacity at Chicago. He has been with Clark for 15 years, including nine years experimental and technical work on a project for the War Department.

Smith

He will be replaced in the Chicago office by Robert C. Smith, who has been working on compressor applications, both reciprocating and centrifugal. Prior to joining Clark he spent a number of years on the Pacific Coast with a major oil company as a project engineer on refinery construction.

M. G. Daniels, a University of Michigan graduate, has been appointed industrial sales engineer in the Chicago office. He has been selling compressors, pumps and engines to the industrial markets for eight years.

Sisson, Rossiter Transferred in Minneapolis-Honeywell Promotion

Minneapolis-Honeywell Regulator Company has named William H. Sisson power industry manager, a promotional transfer from the Indianapolis office where he was industrial manager. From his new headquarters at Philadelphia he will promote product sales in the central station and power fields.

George M. Rossiter has been transferred from Milwaukee to Indianapolis to succeed Sisson as industrial manager.

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Boudreau Appointed Director of Ethyl Public Relations Section

James E. Boudreau has been appointed director of public relations of Ethyl Corporation succeeding Ralph C. Champlin, resigned to become a vice president of the Pennsylvania Railroad Company.

Boudreau

Boudreau who served as sales manager in charge of marketing services until his present appointment, has been associated with Ethyl Corporation for 21 years in various sales, customer services, and advertising capacities.

In 1945 Ethyl's sales department was reorganized on a regional basis and Boudreau was appointed manager of the central region with headquarters in Chicago. He served in that capacity until 1950, when he returned to New York as manager of marketing services for the sales department.

John Roberts, Timken, Dies

John P. Roberts, assistant general manager of The Timken Roller Bearing Company, Service Sales Division, died instantly last month as the result of a car accident in North Carolina which injured two other company employes. P. T. Ancarrow, Atlanta division manager, and W. L. Walthall, salesmen, who had accompanied Roberts as he called on accounts in that area, were the injured.

Dick Olsen Appointed Homestead Valve Division Sales Manager

Homestead Valve Manufacturing Company of Coraopolis, Pa., has appointed G. R. "Dick" Olsen as division sales manager for them in the states of Oregon, Washington, California, Idaho, Nevada, Montana, Wyoming and Colorado.

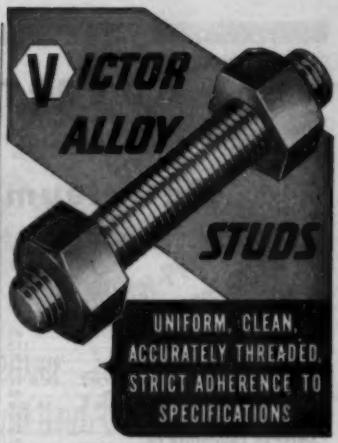
Olsen

Olsen will make his headquarters in Los Angeles.

Prior to joining Homestead Valve he represented W. R. Ladewig Company of Los Angeles, and spent three years as a manufacturers' representative, and 16 years with General Petroleum Corporation.

Van Fossen Appointed to Study Heavy Internal Combustion Units

Assigned to Cooper-Bessemer's regional field office in Seattle, Edward D. Van Fossen will concentrate his efforts in furthering the company's engineering service to users of heavy internal combustion engines, pumps and compressors in the northwest United States. Van Fossen was transferred from the main plant at Mount Vernon, Ohio, where he has been employed the past three years.



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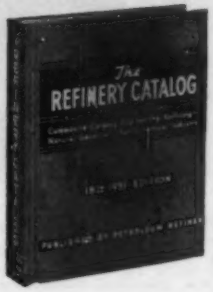

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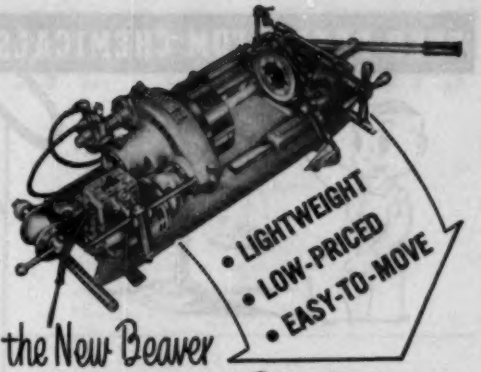

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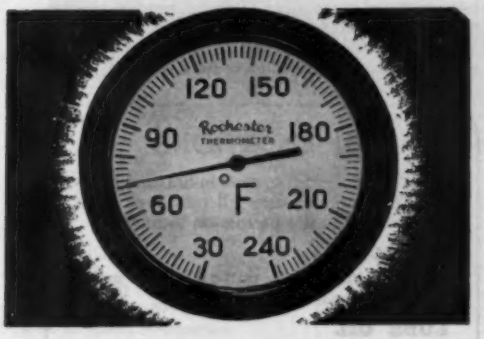

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ROCHESTER GAUGES

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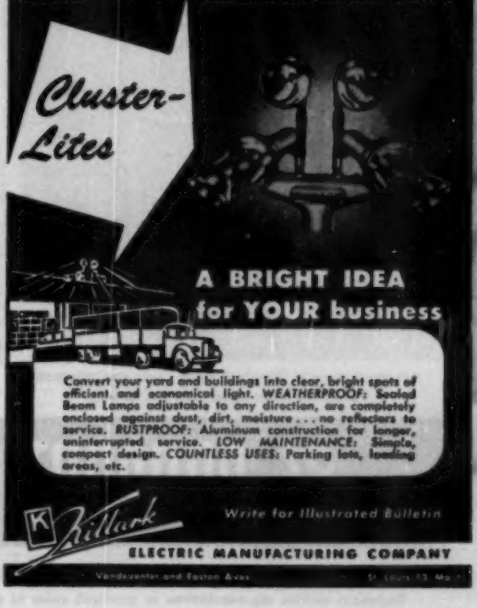

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The Weight-O-Matic is ideally adapted for use in the laboratory or full scale plant production. Units can be supplied for feeding gases, liquids, or slurries. The scale tank can be pressurized or an eductor or gravity feed can be employed for discharging into flowing streams. Because the Weight-O-Matic responds only to weight demand, no correction factors for temperature changes need be applied. Volumetric calibration is also unnecessary. The feed is smooth, continuous, and without pulsation.

The Weight-O-Matic may be equipped with totalizers, recorders, and other accessories. The basic unit contains an alarm circuit which may be connected to a visible or audible alarm system to warn the operator of over- or under-feeding and inform him when the treating chemical reaches minimum and recharging is required.

%Proportioneers% Weight-O-Matic drum size automatic scale for loads up to 1,000 lbs. gross.

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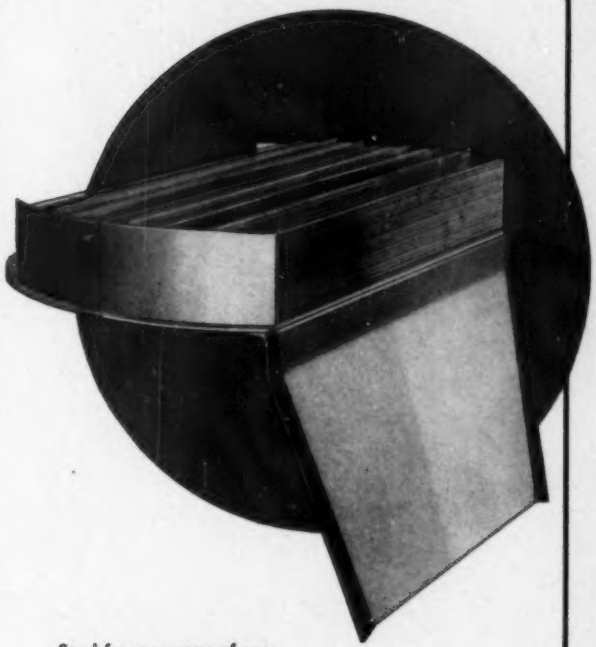

Send for your copy of our new bulletin No. 629 which gives complete information on the new "Benturi" type Kaskade tray.

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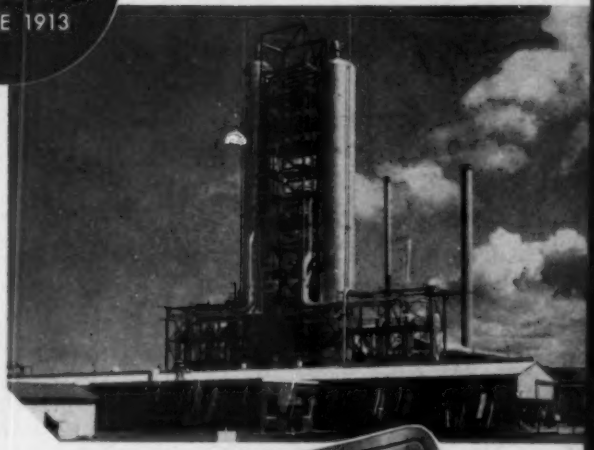

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